Uranium, Radium, and Thorium

By John E. Crawford [1]

ACCOMPLISHMENTS in the United States atomic energy program were manifold in 1953. There were indications of increased interest in uranium prospecting; greater supplies of raw materials were made available; expansion of feed and fissionable materials production centers was realized; more powerful and diversified nuclear weapons were tested; and the potentiality of the nuclear reactor as a source of industrial power became more evident.

The first shipment of uranium ore was made from the Utex mine in San Juan County, Utah, early in 1953. Other promising uranium deposits were located on the Colorado Plateau and elsewhere in the West. Imports of foreign uranium ores and concentrates met expectations. Nine ore-processing plants prepared uranium concentrates from material mined.

The Atomic Energy Commission's feed-materials center at Fernald, Ohio, for production of uranium metal and uranium hexafluoride from uranium-ore concentrates, was put into operation during 1953 by the National Lead Co., and expansion of this facility was begun soon after its completion. The Mallinckrodt Chemical Works, St. Louis, Mo., also operated a refinery for the Commission in 1953.

Expansion of fissionable materials production centers at Hanford, Wash., and Oak Ridge, Tenn., continued; and construction of fissionable materials plants near Aiken, S. C., and Paducah, Ky., and in Pike County, Ohio, showed progress during 1953.

Successful nuclear weapons tests and associated studies were conducted by the Atomic Energy Commission at the Nevada proving grounds in the spring of 1953. The Civil Defense Administration and other Government agencies participated.

The potentialities of the nuclear reactor as a source of industrial power received much attention. Four study groups authorized by the AEC reported their findings with regard to the feasibility of certain types of nuclear reactors for power-generation purposes. Other countries in the Free World indicated a desire to develop uranium resources and construct experimental research reactors.

A private organization to foster and encourage peaceful uses of atomic energy was founded in April 1953. Called the Atomic Industrial Forum, Inc., its board of directors includes many prominent industrialists and educators. Headquarters are in New York City.

Industrial and medical applications of radioisotopes increased. Greater exports of radioisotopes were made in 1953 than ever before. Radioactive isotopes, such as cobalt–60, gold–198, and iodine–131, were in competition with radium in some medical therapy treatments; and cobalt–60, strontium–90, and other radioisotopes proved to be

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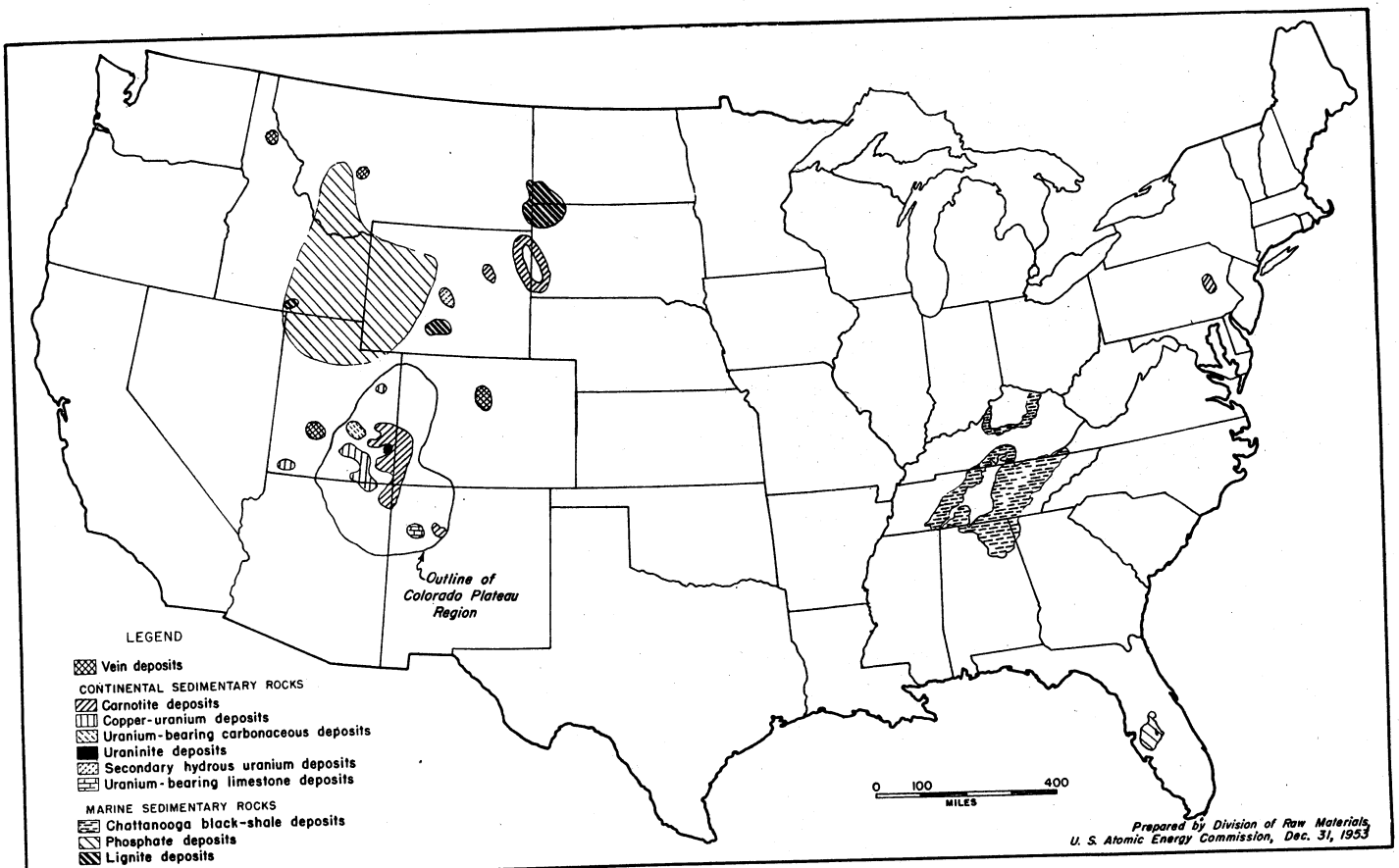

FIGURE 1.—Uranium occurrences in the United States, 1953.

aggressive competitors with radium in industrial fields, such as radiography and luminous markings.

Bureau of Mines engineers were active in exploring for domestic commercial thorium-bearing deposits in 1953. The Lindsay Chemical Co. was in the process of greatly expanding its facilities for producing thorium compounds from monazite. Announcement of the "breeding" of fissionable material in the experimental breeder reactor at Arco, Idaho, gave new life to the hope that thorium may soon be utilized as a source of fissionable uranium–233 on a practicable basis. The new use of thorium as an additive to magnesium alloys to improve qualities of the alloy at ambient and elevated temperatures consumed significant quantities of thorium in 1953.

GOVERNMENT PROGRAMS UNDER THE DEFENSE PRODUCTION ACT OF 1950

Provisions of the Defense Production Act of 1950 with respect to exploration were carried out by the Defense Minerals Exploration Administration (DMEA), and those with respect to procurement by the Defense Materials Procurement Agency (DMPA).

The domestic uranium industry received additional assistance in various forms from Government agencies in 1953. The AEC paid a total of $1,637,698 during the year to uranium miners as a bonus for initial production of uranium, in accord with its Domestic Uranium Program Circular 6, Bonus for Initial Production of Uranium Ores From Domestic Mines (see Uranium, Radium, and Thorium chapter, Minerals Yearbook, 1951); the amount paid compares with a total of $902,551 paid in 1952. Uranium contracts for exploration-project assistance executed by Defense Minerals Exploration Administration in 1953 totaled $537,081 in contract value with $483,373 or 90 percent thereof representing Government participation; these amounts compare with a total contract value of $613,970 and $552,573 or 90 percent thereof in 1952. The exploration contracts executed by DMEA through December 31, 1953, are listed in table 1.

A total of $487,500 was certified for accelerated amortization by the Office of Defense Mobilization in 1953 in connection with facilities for processing uranium ore; the amount compares with $4,119,284 certified for accelerated amortization by the Defense Production Administration in 1952 in connection with the mining of uranium ore and facilities for processing such ore. The certificates of necessity certified by DPA and ODM through December 31, 1953, are listed in table 2.

In 1953 the Bureau of Public Roads completed 497 miles of defense access roads serving uranium mines and was constructing 274 additional miles of such roads; these mileages compare with 160 miles completed and 543 miles under construction in 1952, the year that construction began under the defense program. Detailed statistics of road construction in 1953 and accumulative totals for 1952 and 1953 are presented in table 3.

TABLE 1.—Defense Minerals Exploration Administration contracts involving uranium, by States, through December 31, 1953

Name of contractor	County	Date of contract	Government participation
CALIFORNIA			
Uranium Mines, Inc	Kern	Aug. 11, 1953	$15,867.00
COLORADO			
American Mining Co	Gilpin	Mar. 24, 1953	17,100.00
Anaconda Lead & Silver Co	Eagle	Sept. 15, 1952	9,000.00
Cherokee Mines	Larimer	July 16, 1951	21,600.00
H. C. Gamblin & J. M. Knowles	San Miguel	Oct. 21, 1953	1,159.65
Gateway Mining & Development Co	Mesa	Sept. 26, 1952	46,772.10
Gold Bar Mines, Inc	Clear Creek	Feb. 4, 1953	6,984.00
W. E. Grippe	San Miguel	July 14, 1953	9,225.00
Mack Mining Co	do	May 27, 1953	11,182.50
Moreno-Cripple Creek Corp	Jefferson	May 21, 1952	56,475.00
C. L. Neilson	San Miguel	Oct. 30, 1953	11,362.50
The Realty Co	Gilpin	Oct. 9, 1951	72,000.00
Fred Schwartzwalder	Jefferson	Sept. 2, 1953	20,700.00
J. R. Simplot Co	Montrose	Sept. 8, 1953	50,869.80
Uranium Co. of America	Gilpin	Feb. 25, 1952	22,500.00
Uranium Development Corp	Montrose	Nov. 24, 1952	19,570.00
W. L. Weaver	Garfield	Feb. 12, 1953	1,800.00
Robert Williams	San Miguel	Aug. 27, 1953	22,738.00
MONTANA			
David Nieminen et al	Jefferson	Apr. 17, 1952	13,599.00
Elkhorn Mining Co	do	Aug. 16, 1951	23,125.50
Do	do	Aug. 22, 1951	11,520.00
D. A. McNabb	do	Jan. 16, 1952	20,616.30
NEVADA			
Nevada Uranium Co	Pershing	Dec. 18, 1952	8,230.50
NEW MEXICO			
Black Hawk Consolidated Mines Co	Grant	Apr. 11, 1952	18,000.00
SOUTH DAKOTA			
Mining Research Corp	Fall River	May 14, 1953	47,585.70
C. G. Ortmayer et al	do	May 7, 1953	35,050.50
Oxide Metals Corp	do	Aug. 10, 1953	7,272.00
Urova Co	Custer	Sept. 21, 1953	8,802.00
C. E. Weir	do	June 23, 1953	9,933.30
UTAH			
Beaver Uranium Co	Beaver	Aug. 19, 1953	29,880.00
Boomerang Mining Co	Grand	Nov. 4, 1952	21,705.84
Bullion Monarch Mining Co	Piute	June 23, 1952	24,957.00
Calvin Black et al	San Juan	Dec. 15, 1953	6,480.00
Canary Mining Co	Daggett	Dec. 5, 1951	24,052.50
Abe Day	San Juan	Mar. 17, 1952	9,810.00
J. Walter Duncan, Jr	do	Mar. 4, 1952	38,871.00
Ellihill Mining Co	do	Sept. 4, 1952	17,145.00
Excaliber Uranium Corp	Emery	Jan. 24, 1952	53,363.70
Do	Grand and Emery	Feb. 17, 1953	34,410.00
Gerald Gidwitz	Beaver	Aug. 19, 1953	29,880.00
Glenn Mining Co	Piute	Oct. 15, 1952	29,139.30
R. A. Glenny et al	do	Aug. 19, 1952	22,050.00
Gramlich Minerals, Inc	Emery	Aug. 6, 1953	31,770.00
Kay and Andrew Hunt	do	Apr. 9, 1953	6,631.20
Mineral Uranium Corp	Grand	Aug. 25, 1953	1,215.00
Moreno-Cripple Creek Corp	San Juan	Oct. 29, 1952	19,260.00
Frank and Erma Morgan	Emery	Mar. 23, 1953	2,106.00
Plateau Mining Co	San Juan	Oct. 23, 1951	17,049.60
Red Canyon Mines	do	Nov. 16, 1953	21,600.00
Salina Mining & Smelting Co	Kane	Sept. 10, 1952	15,255.45
Jess and Grant Shumway	San Juan	Feb. 6, 1953	4,050.00
J. R. Simplot	Wayne and Garfield	Dec. 13, 1951	64,340.48
Sunnyside Uranium Co	Piute	Sept. 8, 1952	39,114.00
Thornburg Mining Co	Grand	Nov. 13, 1953	37,719.00
White Canyon Mining Co	San Juan	Feb. 19, 1952	47,138.40
Total			1,269,633.82

TABLE 2.—Certificates of necessity, involving uranium, certified by Defense Production Administration (1951–52) and Office of Defense Mobilization (1953) for assistance through tax amortization, by States, through December 31, 1953

Company	Type of project	Date certified	Percentage of depreciable assets certified	Amount allowed for accelerated amortization
COLORADO				
Climax Uranium Co	Ore-processing facilities	Apr. 16, 1951	90	$817,374.74
Do	Mine buildings and equipment.	May 1, 1951	90	156,329.12
Do	Ore-processing facilities	Nov. 7, 1952	80	226,602.34
Do	Mine buildings and equipment; ore-processing facilities.	Nov. 26, 1952	80	17,698.50
FLORIDA				
Armour & Co	Processing building	Oct. 21, 1953	50	37,500.00
ILLINOIS				
Blockson Chemical Co	Processing equipment	Jan. 13, 1953	75	450,000.00
NEW MEXICO				
Anaconda Copper Mining Co	Ore processing facilities	Jan. , 1952	90	3,197,610.00
UTAH				
Vitro Chemical Co	do	June 5, 1952	80	677,373.32
Total				5,580,488.02

TABLE 3.—Construction in 1953 of defense access roads serving uranium mines and cumulative total for 1952–53

[Bureau of Public Roads]

State	Total work involved			Projects completed			Work accomplished on uncompleted projects		
	Total estimated cost	Access funds	Miles	Total estimated cost	Access funds	Miles	Total estimated cost [1]	Access funds [1]	Miles under contract
Arizona	$513,500	$513,500	90.0	$180,000	$180,000	8.0	$152,085	$152,085	82.0
Colorado	3,137,080	2,787,603	243.8	1,100,965	1,100,695	211.2	398,061	179,682	32.6
New Mexico	159,000	159,000	26.0				4,770	4,770	26.0
South Dakota	110,000	110,000	24.4				108,900	108,900	24.4
Utah	2,069,143	1,920,776	385.9	667,699	624,646	277.3	559,968	519,491	108.6
Total	[2] 5,988,723	[2] 5,490,879	770.1	1,948,664	1,905,341	496.5	1,223,784	964,928	273.6
Cumulative total, 1952–53	[3] 6,360,065	[3] 5,862,221	929.8	2,320,006	2,276,683	656.2	1,223,784	964,928	273.6

[1] Funds based on percentage of work completed.
[3] Difference available from State and county funds.

DOMESTIC PRODUCTION

URANIUM

Raw Materials Program.—Production of domestic uraniferous ores and concentrates under the AEC's Raw Materials Program continued to increase in 1953. Expansion was noted in the uranium-mining industry, and exploration for radio-active materials was unabated during the year.

Ore was produced from more than 525 mines, mostly in the Colorado Plateau area. Some uranium was also recovered in South Dakota, Wyoming, the Colorado Front Range, and the Boulder Batholith area near Boulder, Mont.[2] The first ore shipment from the much publicized Mi Vida claim of Charles A. Steen was made early in 1953, and by December 1953 Utex Exploration Co., the operating company in which Steen holds controlling interest, had shipped over $2,400,000 worth of ore to AEC buying stations. The Mi Vida mine is in the Big Indian Wash district of San Juan County, Utah.[3] The two principal uranium-ore minerals in the Mi Vida mine are the yellow tyuyamunite and soft gray to black, altered uraninite. Owing to the substantial width and thickness of the ore deposit a modified room-and-pillar method of mining was utilized. Little waste has been produced because, except for material from the inclined entry, all mining has been in ore. Thickness of the ore varied from 10 to 23 feet, while drift headings measured about 12 feet in height. No rooms or stopes were started in 1953; all work was still in the development stage. The G & G Mining Co., lessees, recovered ore on part of the Steen property, operated in conjunction with the Utex Exploration Co. Ore shipments by the lessee were about 41 percent of the total shipments from the Mi Vida mine.[4]

In New Mexico the Anaconda Copper Mining Co. outlined a large ore body at the Jackpile mine on the Laguna Indian Reservation west of Albuquerque. The deposit will be mined by open-pit methods.[5] The Santa Fe Railroad and about 20 to 25 other small operators were producing uranium ores from the Grants area of New Mexico.[6]

The Freedom and Prospector mines of the Vanadium Corp. of America yielded most of the uranium ore recovered from the primary vein-type deposits of the Marysvale, Utah, area.[7]

Uranium ore was mined in the vicinity of Pumpkin Buttes, west-central part of the Powder River Basin, Wyo., during 1953. One ore body in the area was mined out, and the ore was shipped to the AEC buying station at Edgemont, S. Dak. The Homestake Mining Co. began to mine carnotite-bearing sandstone near Carlile, Crook County, Wyo., in January 1953. The uranium ore that Homestake Mining Co. recovered was trucked to the AEC buying station at Edgemont, S. Dak. Although there were other uranium occurrences in Wyoming, none were worked for uranium in 1953.[8]

The Kerr-McGee Oil Industries, Inc., of Oklahoma City, Okla., was reported to have planned a major program of exploration and development in northeastern Wyoming. The company conducted an airborne radioactivity reconnaissance and did core drilling in the Pumpkin Buttes area of Wyoming during 1953.

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[2] Atomic Energy Commission, Fifteenth Semiannual Report: January 1954, p. 3.
[3] Waylett, William J., Uranium: Min. World, Apr. 15, 1954, pp. 47–48.
[4] Steen, C. A., Dix, G. P., Jr., Hazen, S. W., Jr., and McLellan, R. R., Uranium-Mining Operations of the Utex Exploration Co. in the Big Indian District, San Juan County, Utah: Bureau of Mines Inf. Circ. 7669, 1953, 13 pp.
Bilyou, Virgil, Mining and Handling Ore in a Large Uranium Operation: Address before meeting of the Colorado Min. Assoc., Denver, Colo., Jan. 29, 1954.
Steen, C. A., Uranium Bonanza: Address before Special Subcommittee on Minerals, Materials, and Fuels Economics, in Salt Lake City, Utah, Nov. 12–13, 1953.
[5] Work cited in footnote 3.
[6] Mining Record, vol. 64, No. 50, Dec. 10, 1953, pp. 1–2.
[7] Work cited in footnote 3.
[8] Thomas, H. D., Uranium in Wyoming: Address before meeting of Colorado Min. Assoc., Denver, Colo., Jan. 28, 1954.

Airborne radiometric survey techniques found greater use in 1953. The AEC, the Geological Survey, and industrial concerns such as Kerr-McGee Oil Industries, Inc., Hunt Oil Co., Jenkins & Hand, and Anaconda Copper Mining Co. have made successful airborne radioactivity surveys.[9] Airborne radioactivity surveys were made of the Mauch Chunk, Pa., area by Safair Flying Services, Inc., Teterboro, N. J. The Safair Co. carried out the work under contract with the AEC.[10] The Federal Geological Survey announced in June the results of airborne radioactivity surveys in the Pumpkin Buttes and Devils Tower regions of Wyoming.[11]

New developments in exploration and mining methods on the Colorado Plateau include the use of 36-inch-diameter calyx drill holes for mine shafts and improvement in long-hole wagon drilling. Miners are utilizing crawler tractors, small diesel shuttle cars, small diesel locomotives, and other more conventional mining equipment in underground operations.[12] A comprehensive report on drilling methods and costs on the Colorado Plateau was published in 1953.[13]

An act of Congress (Public Law 250, 83d Cong.), approved August 12, 1953, validated mining claims located between July 31, 1939, and January 1, 1953, on United States lands under Government oil and gas leases, provided the owner of any such mining claim, not later than December 10, 1953, submitted an amended notice of location of claim to the Land Office where the original claim was filed. Passage of the law will materially aid the exploration for uranium in the western United States where prospectors have been unable to obtain title to lands previously leased for oil and gas rights.[14]

During 1953 the Bureau of Mines conducted for the AEC an exploration drilling program of the low-grade uraniferous Chattanooga shale to determine the distribution of uranium in the shale members. On January 30, 1953, it was announced that the Bureau of Mines would open a small mine in the Chattanooga shale to develop satisfactory methods for full-scale mining of the material. Shale process studies were concurrently being carried out at Columbia University, Battelle Memorial Institute, and the Oil Shale Experimental Plant of the Bureau of Mines, Rifle, Colo.[15]

The AEC continued to investigate the feasibility of extracting uranium, phosphate, and alumina from "leached-zone" material of the Florida land-pebble-phosphate field. Principal research contractors of the AEC in this program are International Minerals & Chemical Corp. and the Tennessee Valley Authority.[16]

Ore-processing capacity was expanded to treat the ever-increasing quantities of ore being mined. The new Anaconda Copper Mining Co. processing plant at Bluewater near Grants, N. Mex., was com-

[9] Work cited in footnote 3.
[10] Atomic Energy Newsletter, vol. 8, No. 12, Jan. 27, 1953.
Mining World, vol. 15, No. 8, July 1953, p. 108.
[11] Geological Survey, Airborne Radioactivity Survey in the Devils Tower Region, Wyo.: U. S. Dept. of the Interior Press release, June 1, 1953. Airborne Radioactivity Survey in the Pumpkin Buttes Region, Wyo.: U. S. Dept. of the Interior Press release, June 10, 1953.
[12] Roberts, G. E., The Colorado Plateau Area: Min. Eng., vol. 6, No. 2, February 1954, p. 157.
[13] Ross, A. E., Drilling in the Colorado Plateau: Address before 5th Ann. Symposium sponsored by the University of Minnesota Center for Continuation Study, Minneapolis, Minn., Oct 14, 15, 1954.
[14] Mining Record, vol. 64, No. 35, Aug. 27, 1953, p. 1.
Defense Minerals Exploration Administration, Mining Claims Staked on Lands Under Government Oil and Gas Leases: Memorandum 22, Sept. 14, 1953, 1 p.
[15] Atomic Energy Commission, Major Activities in the Atomic Energy Programs: January-June 1953, p. 8.
[16] Work cited in footnote 2, p. 7.

pleted in September. With completion of the Anaconda plant there were nine facilities in the United States for treating uranium ores. The Western Machinery Co. of San Francisco announced early in 1953 that it will design, construct, and equip a processing mill for the Kerr-McGee Oil Industries, Inc., at Shiprock, N. Mex. The plant was scheduled for completion by December 1954.[17] It will treat uranium ores produced in the Lukachukai Mountain area of northeastern Arizona and other areas on the Navajo Indian Reservation, as well as ore stockpiled at the Shiprock ore-buying station for about 2 years. The capacity of the Vanadium Corp. of America mills at Naturita and Durango, Colo., was enlarged, as were the facilities of the Climax Uranium Co. at Grand Junction, Colo. The AEC is planning to expand the present Government-owned Monticello mill at Monticello, Utah; this mill is operated for the Commission by the Gallagher Co. of Salt Lake City. Construction of additional plants is being considered by industry.[18]

A unit for recovering low-grade uranium from Florida phosphate rock was completed in October by Texas City Chemicals, Inc., at Texas City, Tex. Uranium concentrates will be recovered as a by-product of an operation producing an animal feed-grade dicalcium phosphate and dicalcium phosphate fertilizer material. International Minerals & Chemical Corp. and Virginia-Carolina Chemical Corp. are constructing similar recovery units at their plants in Bartow and Nichols, Fla., respectively. The Blockson Chemical Co. at Joliet, Ill., has been recovering uranium from Florida phosphate rock as a byproduct of its phosphate chemical operations since September 1952.[19]

The AEC opened a new laboratory in Winchester, Mass., for developing and improving processes for recovering uranium from its ores. The American Cyanamid Co. was selected to operate the laboratory under contract with the AEC.[20] Methods for processing uranium ores were described at conventions during the year.[21]

Feed-Materials Program.—The AEC's Feed-Materials Program, which consists of the refining of uranium ores and concentrates, proceeded during 1953 with an expansion of uranium concentrate refining capacity. The $78 million refining plant at Fernald, Ohio, was completed midway in the year and put into operation for the AEC by the National Lead Co. of Ohio.[22] The Fernald plant includes a uranium rolling mill, the first and only one in the United States designed specifically for producing uranium bars. It was built by

[17] Mining Congress Journal, vol. 39, No. 12, December 1953, p. 83.
[18] Work cited in footnote 2, p. 4 and footnote 3.
Engineering and Mining Journal, vol. 155, No. 1, January 1954, p. 138.
Western Industry, vol. 15, No. 12, December 1953, p. 102.
Nucleonics, vol. 12, No. 2, February 1954, p. 76.
Mining Engineering, vol. 5, No. 10, October 1953, p. 965.
[19] Skillings Mining Review, vol. 42, No. 46, Feb. 20, 1954, p. 22.
Mining Engineering, vol. 6, No. 2, February 1954, p. 191.
Chemical Engineering, vol. 60, No. 12, December 1953, pp. 106, 110.
Barr, J. A., Jr., Remarks for Delivery Before the Phosphate Fertilizers Industry Advisory Committee, National Production Authority: Atomic Energy Commission, Sept. 29, 1953.
Work cited in footnote 2, p. 7.
[20] Mining World, vol. 15, No. 7, June 1953, p. 88.
Nucleonics, vol. 11, No. 7, July 1953, p. 70.
Industrial and Mining Standard, vol. 108, No. 2750, Sept. 17, 1953, p. 5.
[21] Kentro, D. M., Uranium Ore Processing: Address before meeting of Colorado Min. Assoc., Denver, Colo., Jan. 29, 1954.
Swanson, S. J., Methods of Processing Uranium Ores: Address before Am. Min. Cong., Seattle, Wash., Sept. 21–24, 1953.
[22] Chemical Engineering, vol. 60, No. 7, July 1953, pp. 101–102.
Chemical and Engineering News, vol. 31, No. 23, June 8, 1953, p. 2404.

Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.[23] The Mallinckrodt Chemical Works operated a refinery for the Commission at St. Louis, Mo. The two feed-materials refineries produced uranium hexafluoride (UF_6) and uranium metal, which was transported to fissionable materials production centers for manufacture of uranium-235 or plutonium.[24]

Fissionable Materials Program.—The production of uranium–235 continued satisfactorily at the Oak Ridge, Tenn., fissionable materials center operated by Carbide & Carbon Chemicals Co., a division of Union Carbide & Carbon Corp. The installation, which was initially constructed at a cost of about $500 million, had undergone a $200 million expansion after World War II, and a second major expansion program now underway will cost an estimated $464 million. The Union Carbide & Carbon Corp. contract with the AEC was modified in 1953 to include more operational responsibilities at facilities already under its management.[25]

Construction of one $500 million unit of the uranium–235 production center at Paducah, Ky., was completed and the unit put into operation early in 1953. A second $458 million unit is under construction and probably will be completed late in 1954.[26]

A third uranium–235 production plant is being constructed in Pike County, Ohio. The plant will cost an estimated $1.2 billion and will be operated by Goodyear Atomic Corp., a subsidiary of the Goodyear Tire & Rubber Co., Inc.[27]

The American Cyanamid Co. began operating a facility for processing used reactor-fuel elements to recover fissionable material at the AEC's National Reactor Testing Station, Arco, Idaho. The plant cost about $34 million to construct.[28]

RADIUM

Refinery Production.—The Canadian Radium & Uranium Corp., New York, N. Y., was the sole domestic producer of radium in 1953. The Canadian Radium & Uranium Corp. refinery is at Mount Kisco, N. Y. Distributors of radium and radium compounds produced elsewhere are Radium Chemical Co., Inc., New York, N. Y., sales agent for the Union Miniére du Haut Katanga, and United States Radium Corp., New York, N. Y.

A faster, more efficient method of extracting radium from radium-barium solutions was announced. The process, known as the precipitation from a homogeneous solution procedure, was developed at the

[23] American Metal Market, vol. 60, No. 93, May 15, 1953, p. 1.
E&MJ Metal and Mineral Markets, vol. 24, No. 21, May 21, 1953, p. 7.
Materials and Methods, vol. 38, No. 2, August 1953, p. 164.
Iron Age, vol. 171, No. 22, May 28, 1953, p. 138.
[24] American Society of Mechanical Engineers, Uranium, Plutonium, and Industry: November 1952, p.
[25] Work cited in footnote 24, p. 9.
Steel, vol. 133, No. 10, Sept. 7, 1953, p. 63.
Oil, Paint and Drug Reporter, vol. 164, No. 10, Sept. 7, 1953, p. 5.
Atomic Energy Newsletter, vol. 10, No. 3, p. 2.
[26] Work cited in footnote 15, p. 10.
Atomic Energy Newsletter, vol. 10, No. 2, Aug. 25, 1953, p. 1.
Business Week, No. 1620, Oct. 24, 1953, p. 182.
Chemical Week, vol. 73, No. 7, Aug. 15, 1953, p. 16.
[27] Work cited in footnote 24, p. 9.
[28] Atomic Energy Newsletter, vol. 9, No. 3, Mar. 24, 1953, p.3.
Mining Congress Journal, vol. 39, No. 6, June 1953, p. 106.

AEC's Mound Laboratory, Miamisburg, Ohio, operated by the Monsanto Chemical Co.[29]

THORIUM

Exploration and Mine Production.—Field investigations for thorium-uranium minerals in alluvial deposits were continued in 1953 by the Bureau of Mines, on behalf of the AEC, in Georgia, Idaho, Montana, North Carolina, Oregon, South Carolina, and Washington. Churn-drilling projects to evaluate promising placers, as indicated from 1952 field investigations, were conducted in Idaho, Montana, North Carolina, and South Carolina. Bureau engineers located several placer areas in central Idaho that contained appreciable quantities of thorite and uranothorite, and these areas will be explored by bulldozer trenching and churn drilling in the summer of 1954 to determine whether the deposits contain sufficient quantities of these minerals to warrant exploitation by private industry.

The monazite lode deposits in Lemhi County, Idaho, first examined by Bureau engineers in 1951, were explored further by a mining company in 1953. A lode deposit of monazite was discovered during 1953 in San Miguel County, N. Mex. Bulldozer trenching is reported to have disclosed massive monazite 6 to 20 inches thick in a veinlike structure. Analyses of this monazite indicate a thoria content of 10 to 12 percent.

The Lindsay Chemical Co., West Chicago, Ill., took over the options on the thorium deposit of the Rare Earth Mining Co. in Gunnison County, Colo., and plans to develop the property and begin mining in 1954.

In Idaho three dredges (operated by Baumhoff-Marshall, Inc., Idaho-Canadian Dredging Co., and Warren Dredging Co., all of Boise, Idaho), recovered monazite from placer deposits. Two companies recovered monazite in Florida; they were Humphreys Gold Corp., Jacksonville, Fla., and the Florida Ore Processing Co., Sharonville, Ohio.[30] Thorium deposits in the western hemisphere were discussed.[31] Methods for analyzing thorium in ores were published or released during the year.[32]

Refinery Production.—Domestic thorium and thorium-compounds production statistics are classified as security information by the AEC and therefore cannot be published. Producers of thorium compounds directly from monazite concentrates in the United States are Lindsay Chemical Co., West Chicago, Ill.; Maywood Chemical Works, Maywood, N. J.; and Rare Earths, Inc., Paterson, N. J.

The Lindsay Chemical Co. during 1953 was constructing additional facilities for producing rare-earth and thorium compounds. The

[29] Chemical Week, vol. 73, No. 12, Sept. 19, 1953, p. 60.
Mining Record, vol. 64, No. 35, Aug. 27, 1953, p. 4.
Materials and Methods, vol. 38, No. 4, October 1953, pp. 238, 240.
Nuclear Science Abstracts, vol. 7, No. 11, June 15, 1953, p. 370.

[30] Mining Engineering, vol. 5, No. 2, February 1953, p. 164.
Carlson, E. J., Minor Metals chapter (section on Rare-Earth Minerals and Metals). Minerals Yearbook, 1953.

[31] Strod, A. J., Thorium and Its Sources in the Western Hemisphere: Ceram. Bull., vol. 32, No. 4, 1953, pp. 122–123.

[32] Barks, C. V., and Byrd, C. H., Spectrophotometric Determination of Thorium in Monazite Sands: Jour. Am. Ceram. Soc., vol. 36, No. 7, July 1, 1953, pp. 115–130.
Audrieth, L. F., and Buyers, A. G., Determination of Thorium in Monazite Ores by Measurement of Radioactivity: Illinois University, December 1947, 45 pp. (Made available from Library of Congress, Publication Board Project ,Washington ,D. C. 1953.)

expansion program will cost over $2 million. Operation of the new facilities may begin early in 1954. Some of the increased quantity of thorium compounds produced, it is reported, will be sold to the AEC. Lindsay is the largest known producer of thorium compounds in the world.[33]

Commercial facilities for producing thorium metal in the United States are maintained by Metal Hydrides, Inc., Beverly, Mass., and Westinghouse Electric Corp. (Lamp Division), Bloomfield, N. J. Production of thorium metal was negligible in 1953.

A patented process was described for converting massive metallic thorium to powdered thorium.[34]

CONSUMPTION AND USES

URANIUM

Production Reactors.—Probably the greatest part of the uranium metal produced at feed-materials centers was consumed in producing the artificial element plutonium in nuclear reactor systems. The AEC's Hanford, Wash., plutonium-production works, which originally cost about $350 million and had undergone a $200 million expansion program after World War II, was subject to further expansion in 1953. The Kaiser Engineers Division of Henry J. Kaiser Co. progressed on construction of new production facilities costing $110 million, and the Blaw-Knox Construction Co. began work on a $40 million contract to build a new chemical-processing plant. A $2.4 million contract was let to Grove, Shepherd, Wilson & Kreige, Inc., of Seattle to prepare 15 underground storage tanks for radioactive wastes. A $14.2 million laboratory area was completed by L. H. Hoffman, Sound Construction & Engineering Co. of Seattle.[35] The Hanford works are operated by the General Electric Corp.

Construction continued on the Savannah River plutonium-production center near Aiken, S. C., which will cost approximately $1.4 billion when completed. The Savannah River plant will be operated by E. I. du Pont de Nemours & Co.[36]

Propulsion Reactor Systems.—The submarine thermal reactor (STR Mark I), a prototype of the STR Mark II, which will propel the submarine U. S. S. *Nautilus*, began its first phase of operation at the National Reactor Testing Station near Idaho Falls, Idaho. The reactor became "critical" about March 31, 1953. It was to have been tested under full power to determine its operating characteristics and to train the crew of the U. S. S. *Nautilus*. The development of the prototype submarine thermal reactor and of the similar reactor that will be installed in the U. S. S. *Nautilus* was the responsibility of the Argonne National Laboratory and the Atomic Power Division of the Westinghouse Electric Corp.[37]

In September 1953 the keel was laid for the second nuclear-powered submarine, the U. S. S. *Sea Wolf*. The Electric Boat Division of

[33] American Metal Market, Worthington Units to Be Used in New Thorium Nitrate Plant: Vol. 60, No. 161, Aug. 19, 1953, p. 1.
[34] Chemical and Engineering News, vol. 31, No. 22, June 1, 1953, p. 2306.
Atomic Energy Newsletter, vol. 9, No. 6, May 5, 1953, p. 4.
[35] Atomic Energy Newsletter, vol. 9, No. 11, June 30, 1953, p. 2.
Western Industry, vol. 19, No. 1, January 1954, pp. 52, 54.
[36] Work cited in footnote 24, p. 12.
[37] Atomic Energy Newsletter, vol. 9, No. 4, Apr. 7, 1953, p. 4.
Nucleonics, Submarine Thermal Reactor Reaches Criticality: Vol. 11, No. 5, p. 71.

General Dynamics Corp., Groton, Conn., is the contractor in charge of construction of the submarines U. S. S. *Nautilus* and U. S. S. *Sea Wolf*. The prototype of the submarine intermediate reactor (SIR) which will propel the submarine U. S. S. *Sea Wolf* is being constructed at the Knolls Atomic Power Laboratory, West Milton, N. Y., by the General Electric Co. The prototype, Mark A, will be installed in a land-based submarine hull section, inside a steel sphere 225 feet in diameter. The purpose of the sphere is to provide for capture of radioactivity should the reactor fail and radioactive material be released. The submarine intermediate reactor will use medium-speed neutrons for energy and liquid sodium metal as a heat-exchange medium, while the submarine thermal reactor will use slow-speed neutrons for energy and water as the heat-exchange substance. After the submarine intermediate reactor, Mark A, at the Knolls Laboratory has been tested, a similar reactor, Mark B, will be built by General Electric Co. for installation in the U. S. S. *Sea Wolf*.[38]

The Newport News Shipbuilding & Drydock Co., Newport News, Va., will, as a part of its power-reactor study, determine the feasibility of a reactor as a means of ship propulsion. The company previously gained experience in nuclear energy as a subcontractor on the now terminated AEC-Navy program for investigation of a suitable reactor for propelling an aircraft carrier.[39]

The General Electric Co. in 1953 established an aircraft nuclear propulsion department at its Evandale plant, Cincinnati, Ohio. The organization has been active in aircraft nuclear propulsion since 1951.[40] Other AEC research and development contractors in this field are Carbide & Carbon Chemicals Co. at the Oak Ridge National Laboratory and the Pratt & Whitney Aircraft Division of the United Aircraft Corp. at East Hartford, Conn. The Air Force sponsors airframe investigations of three aircraft firms.[41]

Power-Reactor Systems.—The AEC program for designing and developing more efficient nuclear reactors for future power applications advanced in 1953. A project was initiated for construction of the first full-scale, experimental industrial nuclear power plant, and industrial participation in the AEC's nuclear power studies program was enlarged.[42]

The experimental industrial power reactor was authorized by the AEC in July. The Westinghouse Electric Co. will be responsible for the development, design, and construction of the pressurized-water-type reactor, which will have an electrical capacity of at least 60,000 kw.[43]

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[38] Atomic Energy Newsletter, vol. 10, No. 4, Sept. 22, 1953, pp. 1–2.
Chemical and Engineering News, Second Atomic Sub: Vol. 31, No. 33, Aug. 17, 1953, p. 3350.
Engineering News Record, Sphere is Atomic Sub Lab: Vol. 150, No. 15, Apr. 9, 1953, pp. 32, 34–35.
Compressed Air, Subs Will be First: Vol. 59, No. 1, January 1954, pp. 19–20.
[39] Atomic Energy Newsletter, Nuclear Power for Ship Propulsion To Be Studied: Vol. 10, No. 6, Nov. 3 1953, p. 5.
[40] Atomic Energy Newsletter, vol. 10, No. 3, Sept. 8, 1953, p. 1.
[41] Work cited in footnote 2, p. 24.
[42] Work cited in footnote 2, p. 17.
[43] Work cited in footnote 2, p. 18.
Chemical and Engineering News, AEC Gives Go-Ahead for Industry to Build Peacetime A-Power Plant: Vol. 31, No. 44, Nov. 2, 1953, p. 4538.
Scientific American, A Start on Atomic Power: December 1953, p. 48.
Engineering and Mining Journal, AEC Picks Westinghouse to Build Atomic Plant: Vol. 154, No. 11, November 1953, p. 132.
Industrial and Engineering Chemistry, vol. 45, No. 6, June 1953. p. 8–A.

North American Aviation, Inc., announced in May that, under contract with the AEC, it had designed a practical sodium-graphite power reactor. The company indicated that it was willing to plan and build for industry a $10 million, 8,000-kw. prototype reactor based on its designs when conditions permit. The reactor would require slightly enriched uranium metal as fuel, graphite as a moderator, liquid sodium as a heat-transfer agent, and cadmium or boron-steel rods for controlling progress of the reaction.[44]

The Commission authorized five new industrial groups to study reactor technology, make preliminary design and economic surveys, and carry on research and development in the field of nuclear power. The groups, which were authorized in October 1953, are:

1. Duquesne Light Co., Pittsburgh, Pa.
   Walter Kidde Nuclear Laboratory, Inc., New York, N. Y.
2. General Electric Co., Schenectady, N. Y.
3. Newport News Shipbuilding & Dry Dock Co., Newport News, Va.
4. Tennessee Valley Authority, Wilson Dam, Ala.
5. A five-company group consisting of:
   Commonwealth Edison Co., Chicago, Ill.
   Union Electric Co., St. Louis, Mo.
   Bechtel Corp., San Francisco, Calif.
   Pacific Gas & Electric Co., San Francisco, Calif.
   American Gas & Electric Service Corp., New York, N. Y.

The 5-company group contains 4 members of the original 4 teams, American Gas & Electric being the new contractor.

The four original study groups, all active in 1953, are:

1. Detroit Edison-Dow Chemical:
   Allis-Chalmers Manufacturing Co.
   Atlantic City Electric Co.
   Babcock & Wilson Co.
   Bendix Aviation Corp.
   Cincinnati Gas & Electric Co.
   Cleveland Electric Illuminating Co.
   Consolidated Edison Co. of New York
   Consolidated Gas, Electric Light & Power Co.
   Consumers Power Co.
   Detroit Edison Co.
   Dow Chemical Co.
   Ford Motor Co.
   General Public Utilities Corp.
   Gibbs & Cox, Inc.
   Hartford Electric Light Co.
   New England Electric System.
   Niagara Mohawk Power Corp.
   Philadelphia Electric Co.
   Potomac Electric Power Co.
   Public Service Electric & Gas Co.
   Rochester Gas & Electric Corp.
   Southern Services, Inc.
   Toledo Edison Co.
   United Engineers & Constructors, Inc.
   Vitro Corp. of America.
   Wisconsin Electric Power Co.

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[44] Chemical and Engineering News, Plans Drawn Up for Proposed Atomic Power Installation: Vol. 31, No. 23, June 8, 1953, p. 2400.
Steel, North American Lands in Industrial Atom Picture: Vol. 132, No. 26, June 29, 1953, p. 111.
Atomic Energy Newsletter, vol. 9, No. 10, June 16, 1953, p. 2.
Nucleonics, vol. 11, No. 6, June 1953, p. 87.

2. Commonwealth Edison-Public Service:
   American Gas & Electric Service Corp.
   Bechtel Corp.
   Commonwealth Edison Co.
   Pacific Gas & Electric Co.
   Union Electric Co.
3. Foster Wheeler-Pioneer Service & Engineering-Diamond Alkali:
   California-Oregon Power Co.
   Diamond Alkali Co.
   Foster Wheeler Corp.
   Louisville Gas & Electric Co.
   Northern States Power Co.
   Oklahoma Gas & Electric Co.
   Pioneer Service & Engineering Co.
   San Diego Gas & Electric
   Wisconsin Public Service Corp.
4. Monsanto Chemical Co. and Union Electric Corp.:
   Monsanto Chemical Co.
   Union Electric Corp.

In May 1953 surveys prepared by the four original study teams were released. The Commonwealth Edison-Public Service team considered two power-reactor types—a helium-cooled, graphite-moderated design and a heavy-water cooled and moderated design, both employing natural uranium fuel. The Detroit Edison-Dow Chemical team investigated a rapid-breeder power reactor, cooled with liquid sodium and consuming-fluid, uranium-alloy fuels. The Monsanto Chemical-Union Electric team was concerned with modifications of a liquid-sodium-cooled, graphite-moderated power reactor using enriched uranium; and the Bechtel Corp.-Pacific Gas & Electric team studied a heavy-water-moderated power reactor requiring natural uranium fuel and light-water cooling, as well as a rapid-breeder power reactor using enriched uranium with a liquid-sodium cooling system. Although each group investigated a unique reactor design, the significant conclusions reached by all four groups were (1) that nuclear power reactors can be constructed by industry today, with completion in 3 to 5 years, (2) plutonium would have to be produced in the power reactor, processed, and sold to the Government to make the power reactor currently economical, and (3) as technology improves nuclear power will become more competitive with power from conventional fuels.[45]

The Army has undertaken preliminary studies to determine the feasibility of small nuclear reactors to supply electric power for remote military bases like the Thule, Greenland, Air Force station. The objective of the studies is to estimate the costs of power from such small package units and compare them with costs of power from conventional sources.[46]

A small, experimental, homogeneous nuclear reactor at the Oak Ridge National Laboratory was successfully operated during 1953 to produce 1,000 kw. of heat. The heat from the new-design reactor

[45] Atomic Energy Commission, Reports to the U. S. Atomic Energy Commission on Nuclear Power-Reactor Technology: May 1953, 88 pp.
Chemical Engineering, Industry Teams Report on A-Power: Part 1, vol. 60, No. 7, July 1953, pp. 188–192; part 2, vol. 60, No. 8, August 1953, pp. 188–192.
Chemical and Engineering News, AEC Releases Private Industry's Data on Nuclear Power Reactors: Vol. 31, No. 22, June 1, 1953, pp. 2294–2296.
Engineering News Report, vol. 150, No. 23, June 4, 1953, pp. 26-27.
Mining Engineering, vol. 5, No. 7, July 1953, pp. 666–667.
Nucleonics, Nuclear Power Feasibility Studies: Vol. 11, No. 6, June 1953, pp. 49–64.
Western Industry, Atomic Power Report Released: Vol. 18, No. 6, June 1953, pp. 70, 72, 74, 76.
[46] Nucleonics, Army Studies Costs of Small Power Reactors: Vol. 11, No. 10, October 1953, p. 72.
Nucleonics, Market for "Package" Nuclear Power: Vol. 11, No. 4, April 1953, pp. 32–33.

was used to run a turbine-powered generator which produced 150 kw. of electric power. A single homogenous solution serves as a fuel, moderator, and coolant. The heat from the hot, radioactive liquid is removed by pumping the solution through a heat exchanger, the steam from which drives the turbine generator. Operation of this small reactor should provide information regarding the feasibility of the design for similar full-scale power-reactor systems.[47]

In June 1953 it was announced that fissionable plutonium could be produced in a "breeder" reactor at a rate at least equal to the uranium–235 consumed as a fuel in the reactor. The successful experiment was conducted in the experimental breeder reactor (EBR) in Idaho. The significance of the experiment was the demonstration that, in theory, all of the world's supply of minable uranium and thorium can be made to undergo fission.[48]

Major revision of the Atomic Energy Act of 1946 to promote industrial development of nuclear power was proposed in a bill (HR 4687) introduced in Congress by Representative James E. Van Zandt, a member of the Joint Congressional Committee on Atomic Energy. The bill would, among other things, permit private ownership of fissionable materials and reactors, guarantee the supply by AEC of fissionable materials for owners of private power reactors and relax patent restrictions. The AEC had recommended earlier that Congress amend the Atomic Energy Act to permit greater industrial participation in nuclear power investigations.[49]

Many comprehensive articles were published during the year about the potentialities of industrial nuclear power, some of which are listed.[50] Also made public were the results of investigations of materials acceptability in reactor construction.[51]

Research Reactors.—An agreement between the Consolidated University of North Carolina and the AEC provided the North Carolina State College with enough fissionable uranium–235 in 1953

[47] Atomic Energy Newsletter, vol. 9, No. 3, Mar. 24, 1953, p. 3.
Chemical and Engineering News, Electricity From Atoms: Vol. 31, No. 11, Mar. 16, 1953, p. 1063.
Engineering and Mining Journal, New Homogeneous Reactor Produces Atomic Power: Vol. 154, No. 4, April 1953, p. 129.
Industrial and Engineering Chemistry, vol. 45, No. 4, April 1953, pp. 8–A, 9–A.
Nucleonics, Homogeneous Reactor Generates 150 Kw.: Vol. 11, No. 4, April 1953, p. 66.

[48] Atomic Energy Newsletter, vol. 9, No. 10, June 16, 1953, p. 4.
Bulletin of the Atomic Scientists, vol. 9, No. 5, June 1953, p. 195.
Business Week, More Energy From the Atom: No. 1241, June 13, 1953, pp. 30–31.
Chemical Age (London), Atomic Energy Advance, USA Success in "Breeding" Process: Vol. 68, No. 1770, June 13, 1953, p. 888.
Daily Metal Reporter, New Process Will Speed Civilian Atomic Energy: Vol. 53, No. 108, June 5, 1953, pp. 1–2.
E&MJ Metal and Mineral Markets, Atomic Power Plant Breeds Fuel From Uranium–235: Vol. 24, No. 24, June 11, 1953, p. 10.
Industrial and Engineering Chemistry, vol. 45, No. 7, July 1953, p. 8–A.
Northern Miner (Toronto), New Atomic Pile Makes Own Fuel: Vol. 39, No. 12, June 11, 1953, p. 2.
Nucleonics, An Important Milestone: Vol. 11, No. 7, July 1953, p. 7.
Steel, Atomic Milestone, vol. 132, No. 24, June 15, 1953, p. 55.

[49] Chemical and Engineering News, Industry Seeks Atomic Power: Vol. 31, No. 33, Aug. 17, 1953, p. 3374
Nucleonics, Joint Congressional Committee Begins Hearings on Possibilities of Private Nuclear Power Development: Vol. 11, No. 4, April 1953, p. 66. Congress to Get AEC Plan to Amend Atomic Energy Act; Would Permit Private Ownership of Nuclear Power Plants: Vol. 11, No. 5, May 1953, p. 72. Vol. 11, No. 6, June 1953, p. 88.

[50] Benedict, Manson, What Is Delaying Industrial Nuclear Power: Chem. and Eng. News, vol. 31, No. 10, Mar. 9, 1953, pp. 986–990.
Gray, A. G., Atomic Power in Industry: Steel, vol. 132, No. 9, Mar. 2, 1953, pp. 86–92.
Urey, H. C., Power From Nuclear Fission: Chem. and Eng. News, vol. 31, No. 45, Nov. 9, 1953, pp. 4660–4663.
Mining Journal (London), Use of Atomic Power in Inudstry: Vol. 241, No. 6158, Aug. 28, 1953, p. 245.
Cohen, Karl, The Key to Atomic Power: Nucleonics, vol. 11, No. 5, May 1953, pp. 10–13.
Zinn, W. H., Wanted, an Operating Power Reactor: Nucleonics, vol. 11, No. 11, November 1953, pp. 30–31.

[51] Koenig, R. F., New Tests Prove Materials for Nuclear Power Plants: Iron Age, vol. 172, No. 8, Aug. 20, 1953, pp. 129–133.
Evans, G. E., Materials: Nucleonics, vol. 11, No. 6, June 1953, pp. 18–25.

to fuel the small research reactor that had been constructed on the campus. The reactor is the first university-owned research reactor in the United States and will be used to train students in nuclear engineering.[52]

The Pennsylvania State College submitted to the AEC a proposal to build a 100-kw. light-water cooled and moderated reactor utilizing enriched uranium fuel. The college would construct and operate the reactor at no cost to the Government. The AEC gave preliminary approval for the loan of fuel material.[53]

A list of research and experimental reactors in operation in the United States and others in advanced stages of design or construction is given below:

Reactors in operation

Name:	*Location*	*Fuel*
Bulk Shielding Facility (swimming pool).	Oak Ridge National Laboratory, Oak Ridge, Tenn.	Highly enriched uranium.
EBR, Experimental Breeder Reactor.	National Reactor Testing Station, Idaho Falls, Idaho.	Do.
MTR, Materials Testing Reactor.	-----do-----	Do.
LITR, Low-Intensity Test Reactor.	Oak Ridge National Laboratory, Oak Ridge, Tenn.	Do.
SUPO, Superpower Water Boiler.	Los Alamos Scientific Laboratory, Los Alamos, N. Mex.	Highly enriched uranium nitrate solution.
North American Water Boiler	North American Aviation, Inc., Downey, Calif.	Highly enriched uranyl nitrate solution.
HRE, Homogeneous Reactor Experiment.	Oak Ridge National Laboratory, Oak Ridge, Tenn.	Solution of highly enriched uranium and moderator.
CP–3′, Argonne Heavy-Water Reactor.	Argonne National Laboratory, Chicago, Ill.	Uranium.
TTR, Low-Power Thermal Test Reactor.	Knolls Atomic Power Laboratory, Schenectady. N. Y.	Highly enriched uranium.
Raleigh	North Carolina State College, Raleigh, N. C.	Solution of enriched uranium sulfate.
STR, Submarine Thermal Reactor, Mark I.	National Reactor Testing Station, Idaho Falls, Idaho.	Highly enriched uranium.

Reactor in advanced state of design or construction

SIR, Submarine Thermal Reactor, Mark I.	Knolls Atomic Power Laboratory, Schenectady, N. Y.	----------

Isotopes.—Uranium was required to produce radioactive isotopes for research, industrial, and medical purposes during 1953; this is an indirect use of uranium, as reactors presumably are not operated solely for producing isotopic materials. The AEC made 10,679 shipments of radioactive isotopes in 1953, a 17-percent increase over the 9,102 shipments in 1952. The largest single gain was in shipments of nonclassified radioisotopes, showing a 57-percent increase over 1952. There was an 18-percent increase in shipments of iodine–131; and iodine–131 comprised 43 percent of all radioisotope shipments in 1953. (See table 4.)

[52] Atomic Energy Newsletter, vol. 10, No. 4, Sept. 20, 1953, p. 4.
[53] Work cited in footnote 2, p. 35.

Most radioisotopes were produced in the graphite reactor at the Oak Ridge National Laboratory. Brookhaven National Laboratory prepared special radioisotopes, and in October 1953 the low-intensity test reactor (LITR) at Oak Ridge National Laboratory and the materials-testing reactor (MTR) at the National Reactor Testing Station, Arco, Idaho, were also made available for production of special isotopes. The Argonne National Laboratory may produce radioisotopes with the startup of its new CP–5 reactor.

TABLE 4.—Radioisotopes shipped by the U. S. Atomic Energy Commission by kinds, 1946–53, number of shipments

Radioisotope	1946–48 [1] (total)	1949	1950	1951	1952	1953	Total
Iodine–131	1,541	1,537	2,353	3,183	3,867	4,555	17,036
Phosphorus–32	1,486	1,420	1,736	2,112	2,101	2,218	11,073
Carbon–14	279	192	259	342	431	342	1,845
Sodium–24	200	229	286	176	363	335	1,589
Sulfur–35	92	108	125	168	163	204	860
Gold–198 and gold–199	98	36	164	268	431	536	1,533
Cobalt–60	66	64	137	190	147	185	789
Potassium–42	61	75	123	132	107	158	656
Calcium–45	80	68	89	111	104	107	559
Iron–55 and iron–59	79	54	68	67	149	129	546
Strontium–89 and strontium–90	30	19	46	62	94	113	364
Others	530	568	848	1,014	1,145	1,797	5,902
Total	4,542	4,370	6,234	7,825	9,102	10,679	42,752

[1] Shipments in 1946 by Manhattan District, Corps of Engineers, U. S. Army Service Forces.

Bendix Aviation Corp. and Tracerlab, Inc., under contract with the AEC, determined that commercial production and marketing of isotopes by private industry will probably not be feasible for 5 years.

Industry was the largest consumer of isotopic materials, the field of medicine the second largest. By the end of the year 1,858 institutions or organizations had been authorized by the AEC to use reactor-produced radioisotopes.[54]

The Bureau of Mines Bartlesville, Okla., Petroleum Experiment Station made field tests of radioactive iodine (iodine–131) as a water tracer. The tests, conducted in cooperation with Wells Surveys, Inc., indicated that radioactive iodine can be used successfully as a water tracer to determine (1) relative rates and patterns of flow of injected water between water-input and oil-production wells and (2) zones of excessive water entry into oil-production wells.[55] Carbon–14 was also used at Bartlesville in investigations of detergents as additives to water used in the water flooding of oil sands. The Bureau of Mines Rolla, Mo., laboratories used the radioisotope cobalt–60 for (1) a study of defect sensitivity in radiography, (2) production research on high-purity alloys, and (3) zinc die-casting alloy research.

Applications of radioisotopes in metallurgy were discussed. Specifically, the use of radioisotopes was described in the metallurgical field as tracer elements for (1) determining sulfur in coke, (2) quantitative analysis of oxygen in iron, steel, copper, etc., (3) measuring frictional wear, (4) finding solid diffusion of two or more metals, (5) process metallurgy, such as flotation, (6) study of crystal growth,

[54] Work cited in footnote 2, pp. 39–40.

[55] Watkins, J. Wade, and Mardock, E. S., Use of Radioactive Iodine as a Tracer in Water-Flooding Operations: Address before annual meeting of AIME, New York, N. Y., Feb. 13–17, 1954.

(7) determination of whether one atom substitutes for or joins with another in material crystallography, and (8) examination of carbon in carburized steels by autoradiography. Also described was the use of radioisotopes in the metallurgical field as a source of radiation for (1) locating defects in steel and cast iron by radiography, (2) industrial gages, (3) following the flow of liquids in pipelines to determine when changes in liquid types are made, and (4) determining hard-to-locate leaks in pipelines.[56] Tritium as a radioactive tracer isotope in biological and chemical research was explained.[57] Other reports on applications of radioisotopes were published during 1953.[58]

In July 1953 the Isotopes Division of the AEC announced isotope availability and allocation procedures, technical services, and a health safety visitation program and reported on the Federal control of radioisotopes.[59]

A booklet detailing 20 experiments involving the use of radioisotopes and describing how nuclear radiations are detected and measured was made available to the public by the AEC. The booklet was prepared to assist high-school science teachers to illustrate the use of radioactive isotopes.[60] A new catalog containing price list of isotopes and associated services that are available from Oak Ridge National Laboratory was published, effective January 1, 1953.[61]

The radioisotope strontium–90, which gives off no harmful gamma radiation, was reported to have been used by the Navy for personnel markers. The material emits light and will glow in various colors, depending on impurities present in the zinc compound with which it is mixed.

Industrial management personnel of companies interested in incorporating radioisotopes into their research or production activities were invited to attend a symposium on Management Problems in Industrial Application of Radioisotopes, sponsored by the Oak Ridge Institute of Nuclear Studies, Oak Ridge, Tenn.[62]

It was announced that a $6 million isotopic research center and hospital will be constructed at the University of Tennessee about 20 miles from Oak Ridge.[63]

Weapons.—During the spring of 1953, at the Nevada proving grounds of the AEC, a series of atomic weapon tests was made. The 11th and final test explosion of the series was conducted on June 4, 1953. New and improved nuclear weapons performance data essential to military and civil defense studies were collected. The Civil Defense Administration and other Government agencies participated in the tests. Some 18,000 troops from the Army, Navy, Air Force, and

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[56] Boynton, H. C., and Kirshenbaum, A. D., Utility of Isotopes in Metallurgy: Steel, vol. 133, No. 19, Nov. 9, 1953.
[57] Chemical and Engineering News, Tritium Finds Increasing Application in Tracer Chemistry: Vol. 31, No. 31, Aug. 3, 1953, pp. 3184, 3186, 3187.
[58] Iron Age, Isotopes: Vol. 172, No. 19, Nov. 5, 1953, pp. 111–112.
Chemical and Engineering News, Potomac Postscripts: Vol. 31, No. 33, Aug. 17, 1953, p. 3348.
Cockcroft, Sir John, Industrial Applications of Radioactive Materials: Atomics (London), vol. 4, No. 10, October 1953, pp. 245–252.
Whitehouse, W. J., and Putnam, J. L., Radioactive Isotopes, Oxford University Press, London, 1953, 424 pp.
[59] Atomic Energy Commission, Isotopics: Vol. 3, No. 3, July 1953, 9 pp.
[60] Atomic Energy Commission, AEC Issues Booklet to Aid Science Teachers: Press release, Sept. 20, 1953, 2 pp.
[61] Oak Ridge National Laboratory, Isotopes—Radioactive and Stable: Catalog and Price list, Oak Ridge, Tenn., Jan. 1, 1953.
[62] American Metal Market, vol. 60, No. 19, Jan. 28, 1953, p. 14.
[63] Business Week, No. 1262, Nov. 7, 1953, p. 150.

Marines engaged in maneuvers in the proving area to ascertain effects of explosions on military actions.[64]

On August 8, 1953, Russia announced that it had produced the hydrogen bomb and on August 20 that it had exploded such a bomb. The United States tests at Eniwetok Atoll in 1951 and 1952 involved similar explosions.[65]

An atomic artillery shell was successfully fired from the United States Army's new 280-mm. self-propelled cannon during the spring tests. The 85-ton weapon can fire either conventional-type artillery shells or those with atomic warheads.[66]

Early in 1953 the AEC indicated that a plant for processing and assembling nuclear explosives was to be erected 18 miles east of Macomb, McDonough County, Ill., on the Spoon River. Later in the year construction of the facility was canceled owing to developments that would allow existing facilities to turn out the production intended for the Spoon River plant.[67]

Nonenergy Uses.—The Atomic Energy Commission authorized the use of 2,581 pounds of U_3O_8 contained in uranium compounds for nonenergy purposes in 1953 as indicated in table 5, a 47-percent reduction from the 4,901 pounds allowed for use in nonenergy fields in 1952. The largest nonenergy use of uranium compounds was in

TABLE 5.—Consumption of uranium and thorium compounds for nonenergy purposes in the United States, 1949–53, in pounds of contained U_3O_8 and ThO_2

[U. S. Atomic Energy Commission]

Industry	1949	1950	1951	1952	1953
URANIUM (U_3O_8 EQUIVALENT)					
Chemical (including catalytic)	2,426	2,835	2,016	3,048	2,539
Ceramic (including glass)	270	938	875	1,627	--------
Electrical	103	33	88	226	42
Total U_3O_8	2,799	3,806	2,979	4,901	2,581
THORIUM (ThO_2 EQUIVALENT)					
Magnesium alloys					3,600
Gas-mantle manufacture	44,621	48,471	31,132	25,427	8,707
Refractories and polishing compounds	1,847	1,889	3,382	1,157	236
Chemical and medical	596	2,097	6,246	11,064	5,179
Electrical	237	314	1,457	277	1,222
Total ThO_2	47,301	52,771	42,217	37,925	18,944

[64] Atomic Energy Newsletter, vol. 8, No. 13, Feb. 10, 1953, p. 1.
Atomic Scientists News, Weapons Development: Vol. 2, No. 6, July 1953, pp. 387–389.
Bulletin of the Atomic Scientists, Nevada Weapons Test: Vol. 9, No. 3, April 1953, pp. 73–75. Nevada Tests Completed: Vol. 9, No. 5, June 1953, p. 195.
Iron Age, A-Bomb Test Blast Echoes Into Industry: Vol. 171, No. 13, Mar. 26, 1953.
Work cited in footnote 2, p. 49.

[65] Atomic Scientists Journal, The Hydrogen Bomb, USA and Russia: Vol. 3, No. 2, November 1953, pp. 106–110.
Chemical Engineering, Tritium, Fuel for the Hell Bomb: Vol. 60, No. 2, February 1953, p. 103.
Atomic Energy Newsletter, vol. 10, No. 1, August 11, 1953, p. 1.
Titterton, E. W., The Development of the Hydrogen Weapon: Atomics (London), vol. 4, No. 10, October 1953. pp. 253–256.

[66] Atomic Energy Newsletter, vol. 9, No. 2, Mar. 10, 1953. p. 1.
Arnold, Rudy, The Shot Heard Round the World: Steelways, April 1953, pp. 12–13.
Metal Progress, The Army's Big Gun: Vol. 63, No. 2, February 1953, pp. 94–95.
Washington (D. C.) Post, Army to Fire First Atomic Artillery Shell From 280-Mm. Cannon in Spring Tests: Mar. 8, 1953.

[67] Work cited in footnote 2, p. 12.
Atomic Energy Newsletter, vol. 8, No. 13, Feb. 10, 1953, p. 2.
Chemical Engineering, New AEC Plant in Illinois Will Process Explosives: Vol. 60, No. 4, April 1953 pp. 125–126.
Industrial and Engineering Chemistry, vol. 45, No. 3, March 1953, p. 8–A.
Metals, vol. 5, No. 12, December 1953, p. 1609.

the chemical industry, but the 2,539 pounds consumed in 1953 was 17 percent less than the quantity used for the same purpose in 1952. Although 1,627 pounds of contained U_3O_8 was authorized for use as a coloring agent in the ceramic and glass industry in 1952, no uranium was consumed in this field in 1953. The use of uranium compounds in the electrical industry receded from 226 pounds of contained U_3O_8 in 1952 to 42 pounds in 1953, a drop of some 81 percent.

RADIUM

Leases of radium for medical and scientific uses increased in 1953, but leases of radium for radiographic purposes decreased slightly. Limited quantities of radium were used in luminous compounds and static elimination equipment; radioisotopes were available for use in certain industrial fields, and their competition with radium was probably most evident in teletherapy medical treatment and radiography work. The use of radium-bearing carnotite slimes as a marking compound in oil-well casing increased significantly in 1953.

The care of radium salts hermetically sealed in suitable containers for scientific or therapeutic purposes was discussed.[68]

THORIUM

Authorizations by the AEC for industrial procurement of thorium compounds for nonenergy purposes in 1953, as indicated in table 5, totaled 18,944 pounds of contained ThO_2, 50 percent less than the 37,925 pounds authorized in 1952. Authorizations for refractories and polishing compounds, for which use only 236 pounds of contained ThO_2 was authorized, were 80 percent less than in 1952; authorizations for chemical and medical uses amounted to 5,179 pounds of contained ThO_2, 53 percent less than in 1952; and authorizations for gas-mantle manufacture amounted to 8,707 pounds of contained ThO_2, 66 percent less than in 1952. The only increase in authorizations in 1953 was in the electrical equipment field; 1,222 pounds of ThO_2 was allowed—341 percent more than in 1952. In the electrical industry thorium oxide is reduced to thorium metal powder, bar, and sheet, some of which is alloyed with tungsten to produce filaments having high resistance to shock.

A new, and apparently significant, use for thorium was recognized in 1953. Some 3,600 pounds of contained ThO_2 was consumed as an additive to magnesium alloys. Although thorium is a relatively expensive alloying element, preliminary research has indicated that as much as 3 percent thorium imparts outstanding mechanical properties to magnesium alloys at ambient and elevated temperatures.[69]

Gordon Dean, Chairman of the Atomic Energy Commission, announced on June 4, 1953, at a meeting of members of the Edison Electric Institute, the successful "breeding" of fissionable material. The experimental breeder reactor at the National Reactor Testing Station in Idaho, it was explained, produced fissionable plutonium in quantities equal to the fissionable uranium-235 consumed as fuel in the reactor. With regard to thorium, Dean indicated that the proof of success in breeding at the Idaho station suggests, in addition, that

[68] Lind, S. C., Care of Radium Salts: Nucleonics, vol. 11, No. 4, April 1953, pp. 56–57.
[69] Steel, Thorium Improves Magnesium Alloys: Vol. 133, No. 14, December 1953, pp. 126, 128.

the other potential atomic fuel, thorium, may also ultimately be utilized. Thorium, however, was not used in this particular experiment, and it was not implied that its susceptibility to breeding has been proved.[70]

PRICES

Uranium Ore.—Prices paid by the AEC in 1953 for domestic uranium ore were the same as in 1952 and in accord with the schedule and bonus plan effective March 1, 1951 (see Uranium, Radium, and Thorium chapter, Minerals Yearbook, 1951). In September 1953 the AEC announced that the expiration date of the guaranteed minimum price schedule for uranium ores of the Colorado Plateau area, as set forth in Domestic Uranium Program Circular 5, Revised, had been extended to cover the period through March 31, 1962, from the previous expiration date of March 31, 1958, and that the expiration date of the bonus plan applying to initial production of uranium ore from new domestic mines, as set forth in Domestic Uranium Program Circular 6, had been extended to cover the period through February 28, 1957, from the previous expiration date of February 28, 1954.[71]

In January 1953 the AEC issued a comprehensive report covering a survey conducted by the Colorado School of Mines Research Foundation of all phases of uranium-ore sampling as practiced at ore-buying facilities on the Colorado Plateau.[72] Improvements effected, as a result of the survey, were announced by the AEC in April 1953.[73]

Acceptable domestic uranium ore was purchased at the following 6 ore-buying stations and 7 qualified uranium mills:

Ore-buying stations

Location:	*Operating company*
Grants, N. Mex.	Anaconda Copper Mining Co., on behalf of AEC.
Shiprock, N. Mex.	American Smelting & Refining Co., on behalf of AEC.
Edgemont, S. Dak.	Do.
Marysvale, Utah	Do.
Monticello, Utah	Do.
Thompson, Utah	United States Vanadium Co. for company account.

Qualified uranium mills

Durango, Colo.	Vanadium Corp. of America.
Grand Junction, Colo.	Climax Uranium Co.
Naturita, Colo.	Vanadium Corp. of America.
Rifle, Colo.	United States Vanadium Co.
Uravan, Colo.	Do.
Hite, Utah	Vanadium Corp. of America.
Salt Lake City, Utah	Vitro Chemical Co.
Monticello, Utah	Galigher Co., on behalf of AEC.

[70] Luntz, J. T., An Important Milestone: Nucleonics, vol. 11, No. 7, July 1953, p. 7.
E&MJ Metal and Mineral Markets, Atomic Power Plant Breeds Fuel from Uranium-235: Vol. 24, No. 24, June 11, 1953, p. 10.
Chemical Age (London) Atomic Energy Advance: Vol. 68, No. 1770, June 13, 1953, p. 888.
Business Week, More Energy From the Atom: No. 1241, June 13, 1953, pp. 30-31.
[71] Atomic rnergy Commission, Uranium Ore Price and Initial Production Bonus Schedules Extended: Press release, Sept. 23, 1953, 2 pp.
Mining World, vol. 15, No. 11, October 1953, p. 83; vol. 15, No. 12, November 1953, p. 101.
Engineering and Mining Journal, vol. 154, No. 11, November 1953, pp. 128-129.
[72] Atomic Energy Commission, Uranium-Sampling Report Issued: Press release, Jan. 11, 1953, 2 pp.
Mining World, vol. 15, No. 2, February 1953, p. 87; vol. 15, No. 3, March 1953, p. 105.
[73] Atomic Energy Commission, Uranium-Ore Samplers Improve Practices: Press release, Apr. 12, 1953, pp.
Mining World, vol. 15, No. 7, June 1953, p. 111

The AEC announced in May 1953 establishment of a list of certified uranium umpire analysts available to buyers and sellers of uranium ores in the Colorado Plateau area. Three private firms and the National Bureau of Standards comprised the list; the private firms were: Brown Laboratory, Grand Junction, Colo.; Smith's Laboratory, Moab, Utah; and Ledoux & Co., Inc., New York, N. Y.[74]

Uranium.—Small quantities of high-purity uranium metal were available throughout 1953 to AEC licensees at about $50 a pound. The metal, in the form of pencil-size rods about 4 inches long, was produced by Mallinckrodt Chemical Co., St. Louis, Mo., and distributed to all the major chemical companies, from which the metal was available to the licensees in its original rod form, as rolled sheets, or as foil.

Under the date of September 24, 1953, the AEC announced proposed amendments to its licensing regulations that would (1) provide for an extension of the general license to subcontractors of the Commission and to certain private and Government laboratories having continuing requirements for small quantities of refined source material in the course of normal operations and activities, (2) reduce the allowable quantity to a realistic level in accordance with the actual requirements of the group for whom the general licenses were designed, and (3) reflect changes in the designation and address of the organizational unit to which license applications and communications regarding the regulations should be addressed.[75] The regulations were so amended as of January 1, 1954.

Radium.—Radium was quoted by E&MJ Metal and Mineral Markets at $20 to $25 per milligram of radium content, depending on quantity, from January 1 to February 12, 1953, when the quotation was reduced to $16 to $21.50; the latter quotation continued unchanged for the remainder of the year. One source, however, offered radium element throughout the entire year at $16 to $21.50 per milligram, depending on quantity.

Thorium.—Thorium metal, in the form of powder, unsintered bars, sintered bars, sheet—0.005 inch and over, and sheet—0.002 to 0.0049 inch, was quoted in 1953 by 1 producer, f. o. b. producer's plant, in lots of less than 200 grams per item at 45, 50, 65, 75, and 85 cents per gram, respectively; and, in lots of 200 grams or more per item at 35, 40, 50, 60, and 70 cents per gram, respectively.

Average prices in 1953 for thorium nitrate and oxide were reported by a large producer, in 100-pound lots, f. o. b. producer's plant, as follows: Thorium nitrate, mantle grade—domestic price $3.00, export $3.35 per pound; thorium oxide, 97 percent ThO_2—domestic price $6.30 per pound; thorium oxide, photographic-lens grade, 99 percent ThO_2—$7.63 per pound.

Isotopes.—No appreciable change was made in 1953 in the list of isotopic materials available through the Isotopes Division of the AEC.[76] The only significant change in pricing involved a discount, effective July 1, 1953, on quantity purchases of carbon–14, phospho-

[74] Atomic Energy Commission, Umpire Analysts of Uranium Ore: Press release, May 24, 1953, 2 pp.
Mining World, vol. 15, No. 9, August 1953, p. 99.
[75] Federal Register, vol. 18, No. 192, Oct. 1, 1953, pp. 6267–6268.
[76] Atomic Energy Commission (Oak Ridge National Laboratory, Oak Ridge, Tenn.), Isotopes—Radioactive and Stable: Catalog and Price List. Jan. 1, 1953, 123 pp.
Nucleonics, vol. 11, No. 6, June 1953, p. 85.

rus–32, and iodine–131 from the Oak Ridge National Laboratory, according to the following schedule:[77]

Carbon–14: A reduction from $36 to $32 per millicurie on single shipments of 200 millicuries or more.
Phosphorus–32: A reduction from $1.10 to $1.00 per millicurie on single shipments of 250 millicuries or more.
Iodine–131: A reduction from 75 cents to 65 cents per millicurie on single shipments of 500 millicuries or more.

The change represents a reduction in prices ranging from 10 to 13 percent on these shipments.

Distribution of radioisotopes for cancer research and therapy at an 80-percent reduction from catalog prices was continued by the AEC in 1953.[78]

FOREIGN TRADE [79]

Belgian Congo and Canada continued, during 1953, to supply the United States with substantial quantities of uranium ores and concentrates. In addition, the Union of South Africa began shipping to the United States uranium concentrates recovered from the Rand gold deposits. The Radium Hill mine and the Rum Jungle deposit in Australia were developed.[80]

The AEC made 713 shipments of radioisotopes to foreign countries during 1953, 73 percent more than in 1952. Recipients of the most shipments were Canada, Cuba, and Japan, with 36, 11, and 13 percent of the total shipments, respectively. Phosphorus–32 and iodine–131 made up 52 percent of all shipments.[81] The Commercial Products Division, Atomic Energy Control Board of Canada made more than 1,000 shipments of radioisotopes during the 12-months period ending March 31, 1953.[82] Great Britain made 12,159 shipments of radioisotopes in 1953 and was the world's largest exporter of radioisotopes.

Table 6 shows United States imports of radium salts and radioactive substitutes in 1953. The 96,750 milligrams of radium salts imported

TABLE 6.—Radium salts imported for consumption in the United States, 1949–53

[U. S. Department of Commerce]

Year	Radium salts			Radioactive substitutes (value)
	Milligrams	Value		
		Total	Average per gram	
1949	98,032	$1,719,656	$17,500	$370
1950	80,969	1,235,511	15,300	6,106
1951	89,805	1,225,564	13,600	5,399
1952	173,711	2,873,688	16,500	85,849
1953	96,750	1,662,106	17,200	175,387

[77] Atomic Energy Commission (Isotopes Division, Oak Ridge, Tenn.), Isotopics: Vol. 3, No. 3, July 1953, p. 1.
[78] Work cited in footnote 77, p. 1.
[79] Figures on imports and exports (unless otherwise indicated) compiled by Mae B. Price and Elsie D. Page, Division of Foreign Activities, Bureau of Mines, from records of the U. S. Department of Commerce.
[80] Work cited in footnote 2, p. 5.
[81] Work cited in footnote 2, p. 105.
[82] Atomic Energy Control Board of Canada, Seventh Annual Report, 1952–53: Ottawa, Canada, Mar. 31, 1953, p. 9.

in 1953 was 44 percent less than the quantity imported in 1952, but the average dollar value per milligram of radium salts increased 4 percent from $16.50 in 1952 to $17.20 in 1953. The value of radioactive substitutes imported increased 104 percent in 1953.

WORLD REVIEW

President Eisenhower on December 8, 1953, before the United Nations assembly in New York, proposed that the United Nations create a stockpile of natural uranium and fissionable materials from contributions of all countries possessing atomic raw materials. This stockpile would be used to develop nuclear energy for peaceful purposes for the benefit of all countries of the world.[83]

The Sixth Tripartite Declassification Conference was held at Chalk River, Canada, April 8–10, 1953. In attendance were representatives of the Governments of Canada, United Kingdom, and United States. The subject of the meeting largely concerned the declassification action, consistent with security, required of the three countries for most rapid progress in the development of nuclear power.[84] After the meeting it was declared that the release of additional information on power reactors and related materials technology had been approved by the Governments of Canada, United Kingdom, and the United States. The release of the data is the result of the revision of the Tripartite Declassification Guide.[85]

In October 1953 United States and British representatives conducted a series of conferences in Washington, D. C., regarding the exchange of information on nuclear energy and the possibility of a greater cooperative effort.[86] It was announced in November that an exchange of information on the effects of atomic and hydrogen weapons would be made between the United States, Canada, and Great Britain. No exchange of information about weapons design and development would be allowed, inasmuch as the Atomic Energy Act of 1946 forbids such an exchange.[87]

A. B. Atomenergi of Sweden and the Commissariat a l'Energie Atomique of France collaborated in certain fields of nuclear research. France supplied the Swedish organization with natural uranium fuel rods for the reactor it was constructing in Stockholm, Sweden, and Sweden in return shipped uranium oxide to France.[88]

An international conference on atomic energy for nuclear power was held at Oslo, Norway, in August 1953; scientists from 19 countries were present. The conference unanimously voted to establish an international nuclear energy association open to interested scientists from all nations.[89]

Gordon Dean discussed the progress in atomic research of the United Kingdom, Canada, France, Norway and The Netherlands, Belgium,

[83] Atomic Energy Newsletter, vol. 10, No. 9, Dec. 15, 1953, p. 1.
[84] Atomic Scientists News, vol. 2, No. 6, July 1953, p. 374.
[85] Canadian Chemical Processing, vol. 38, No. 2, February 1954, p. 86.
Nucleonics, vol. 12, No. 1, January 1954. p. 73.
[86] Atomic Energy Newsletter, vol. 10, No. 6, Oct. 20, 1953, p. 1.
[87] Atomic Energy Newsletter, vol. 10, No. 8, Dec. 1, 1953, p. 1.
Business Week, No. 1265, Nov. 28, 1953, p. 34.
[88] Atomics and Atomic Technology, vol. 5, No. 2, February 1954, p. 60.
[89] Atomic Energy Newsletter, vol. 10, No. 2, Aug. 25, 1953, p. 3.
Bulletin of the Atomic Scientists, vol. 9, No. 10, December 1953, p. 387
Nucleonics, vol. 11, No. 10, October 1953, p. 76.

Sweden, Denmark, Germany, Italy, Switzerland, India, Brazil, Australia, and the U. S. S. R.[90]

Research on heavy-water natural uranium power-reactor systems continued satisfactorily at the Joint Establishment for Nuclear Energy Research, Kjeller, Norway; this is a cooperative effort by The Netherlands and Norway. Isotopes produced in the experimental reactor are distributed to organizations in The Netherlands, Norway and other European countries where practicable.[91]

NORTH AMERICA

Canada.—C. J. Mackenzie retired as president of Atomic Energy of Canada, Ltd., effective October 31, 1953. W. J. Bennett, president of Eldorado Mining & Refining, Ltd., was named as his successor by the directors.[92]

Repair of the NRX reactor at Chalk River continued in 1953. On December 12, 1952, a rapid buildup of power in the NRX reactor, combined with an insufficient supply of cooling water, caused rupture and vaporization of uranium fuel rods. The accident released excessive quantities of radioactive gases through the exhaust stack, which, owing to unusual atmospheric conditions, were not dissipated properly, and the area was subsequently contaminated. The station was decontaminated as soon as possible, and the reactor is now being rebuilt.[93]

Construction was begun on the NRU heavy-water reactor. The new installation will probably be completed in 1955 at a total cost of about $30 million.[94]

The Ontario Hydro-Electric Power System announced that it apportioned some $200,000 for a 2-year feasibility study of nuclear energy for power in Ontario. The study received the endorsement and cooperation of Atomic Energy of Canada, Ltd.[95]

Eldorado Mining & Refining, Ltd., was the only producer of uranium in Canada during 1953, with production from the Port Radium properties at Great Bear Lake and some initial production from the Ace-Fay mine in the Beaverlodge region northeast of Lake Athabaska. A 500-ton-per-day-capacity mill will treat ores from the Ace-Fay mine. Cost of Eldorado's new Beaverlodge project is estimated at $17 million.[96]

Eldorado Mining & Refining, Ltd., continued development work on the RA and Bolger group of claims in the Beaverlodge region, as well as exploration work on the Radiore claims in the same area, leased from Radiore Uranium Mines, Ltd.

Also in the Beaverlodge region Gunnar Gold Mines, Ltd., as a result of an extensive drilling program, announced that uranium reserves on its property were estimated to be worth over $65,000,000.

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[90] Dean, Gordon, We Are in a Life-and-Death Atom-Bomb Race: Look (magazine), vol. 17, No, 14, July 14, 1953.
[91] Randers, Gunnar, The Dutch-Norwegian Atomic Energy Project: Bull. Atom. Sci., vol. 9, No. 16, December 1953, pp. 369–371.
[92] Department of Trade and Commerce, Ottawa, Canada, press release, Information Branch, Sept. 19, 1953, 1 p.
[93] Bulletin of the Atomic Scientists, vol. 9, No. 1, February 1953, p. 30.
Nucleonics, vol. 11, No. 3, March 1953, p. 70.
Atomic Energy Newsletter, vol. 9, No. 12, July 14, 1953, p. 4.
[94] Chemistry and Industry (London), New Heavy-Water Reactor for Canada: No. 5, Jan. 31, 1953, p. 108.
[95] Atomic Energy Newsletter, vol. 10, No. 8, Dec. 1, 1953, p. 1.
[96] Engineering and Mining Journal, vol. 154, No. 7, July 1953, p. 140.

Plans are being made by the company for construction of an acid-leaching plant. Open-pit mining may begin in 1955.

Underground exploration was done on (1) the Ace and A. B. C. properties of Nesbitt LaBine Uranium Mines, Ltd., (2) the Smitty zone of Rix-Athabasca Uranium Mines, Ltd., and claims of (1) Beaver Lodge Uranium Mines, Ltd., (2) Beta-Gamma Mines, Ltd., (3) Meta Uranium Mines, Ltd., (4) National Exploration, Ltd., (5) Pitch-Ore Uranium Mines, Ltd., and (6) Strike Uranium Mines, Ltd. Most of these companies, all in the vicinity of the Eldorado Mining & Refining, Ltd., Beaverlodge properties, probably will ship ore to the Eldorado plant for custom milling.

Scattered occurrences of uranium mineralization were explored in other areas of the Beaverlodge region, the Foster Lake region, and the Lac La Ronge region, of Saskatchewan.

In the Northwest Territories mining progressed normally at the Eldorado Mining & Refining, Ltd., properties at Port Radium on Great Bear Lake.[97] The gravity mill, which treated mine ore only, was in continuous operation throughout the year for the first time since the mill was destroyed by fire in 1951. The acid-leach plant, which treated tailings from the gravity mill, plus tailings from earlier operations, was in operation for the full 12 months—the first time in its history; and dredging of old tailings from Great Bear Lake proceeded without undue difficulty. As a result, production in 1953 at the Port Radium operation was the highest in the life of the mine. The mine-development program at Port Radium included 6,398 feet of drifting and crosscutting, 2,339 feet of raising, and 550 feet of shaft sinking. Exploration diamond drilling totaled 1,898 feet on surface and 24,169 feet underground. Footage of holes drilled for grouting was 24,979 by diamond drill and 4,277 by sectional steel and rock drill.[98]

Claims for uranium mineralization were staked and some drilling was done in the Marian River region, Ingray Lake area, Hottah Lake area, Trout Rock region, Stark Lake region, and the Rourangeau Lake area, Northwest Territory.

A radioactive conglomerate bed at the former Breton property in Long Township, Lake Huron region, Ontario, was found. Pronto Uranium Mines, Ltd., developed the deposit. An adit was driven to obtain bulk samples for metallurgical tests.

Algoma Uranium Mines, Ltd., examined uranium occurrences at Quirke Lake, Pecors Lake, and Elliot Lake in the Lake Huron region, Ontario.

In the North Bay region, Ontario, Beaucage Mines, Ltd., did much diamond drilling to explore columbium-uranium discoveries on and near the Manitou Islands in Lake Nipissing.

In the Haliburton-Bancroft region, Ontario, near Wilberforce, Central Lake Uranium Mines, Ltd., did extensive trenching and diamond drilling, which indicated that a large tonnage of material averaging 0.08 to 0.10 percent U_3O_8 may be available. An adit was driven. Croft Uranium Mines prospected and drilled an extension of the zone on adjoining property.

[97] Department of Mines and Technical Surveys, Uranium in Canada in 1953—Preliminary: Ottawa, Canada, p. 4.
[98] Eldorado Mining & Refining, Ltd., Annual Report, 1953: 19 pp.

Newkirk Mining Corp., financing drilling on the Faraday property west of Bancroft, Ontario, is reported to have outlined a uranium-bearing deposit for a width of 28 feet and a length of 320.

In British Columbia during 1953 drilling was continued on the Rexspar property, about 90 miles north of Kamloops. The main zone of mineralization is said to consist of some 160,000 tons of material. An adit was driven for underground exploration and drilling. Similar mineralization was found on the adjoining Deer Horn Mines, Ltd., claims.

Pitchblende was reported to have been found near Fidler Point on Lake Athabaska about 80 miles west of Beaverlodge and at Leggo Lake about 30 miles east of Fitzgerald in the Province of Alberta.

The only uranium exploration in Manitoba in 1953 centered around the Dion Lake property, Herb Lake region. The uranium mineralization was of pegmatitic origin and localized.

There was much staking of claims in the Maniwaki region and in and near Grand Calumet Island and Huddersfield Townships of Quebec. Prospecting and exploration also took place in the vicinity of St. Simeon and Seven Islands; 45 new radioactive properties were reported in Quebec.[99]

The recovery of uranium from Canadian ores was described by the director of research and development, Eldorado Mining & Refining, Ltd.[1]

Mexico.—The National Institute for the Investigation of Mineral Resources asked for an increase in its 1953 budget to intensify its search for uranium and thorium deposits. The request was for 5,000,000 pesos ($570,000); the 1952 allotment was 2,000,000 pesos ($231,000).[2]

The institute examined reported uranium discoveries in Oaxaca, mostly on the Isthmus of Tehuantepec.[3]

SOUTH AMERICA

Argentina.—The National Commission for Atomic Energy announced that the Government of Argentina will purchase all uranium produced in that country. A sliding price scale based on the uranium content of the ore has been developed; the current schedule will be valid for 1 year from the date of issuance. Stockholders of uranium investments have been informed that all stock must be sold to the National Commission of Atomic Energy.[4]

The Argentine Government reportedly made its first purchase of uranium ore—2,750 kilos—from the Santa Ana mine in the State of San Luis.[5] A concentrator for uranium ores will be constructed by the National Commission for Atomic Energy near Malargue in the State of Mendoza, where an important discovery of carnotite was reported.[6]

Bolivia.—Uranium mineralization was purported to have been discovered in an unspecified area of eastern Bolivia.[7]

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[99] Work cited in footnote 97, pp. 4–7.
[1] Thunaes, A., Recovery of Uranium From Canadian Ores: Canadian Min. and Met. Bull., vol. 47, No 503, March 1954, pp. 128–130.
[2] Mining World, vol. 15, No. 4, Apr. 1, 1953, p. 67.
[3] Mining World, vol. 15, No. 11, October 1953, p. 98.
[4] Atomic Energy Newsletter, vol. 9, No. 6, May 5, 1953, p. 3.
[5] Atomic Scientists Journal, vol. 3, No. 3, January 1954, p. 152.
[6] Engineering and Mining Journal, vol. 155, No. 1, p. 158.
[7] Mining World, vol. 15, No. 2, February 1953, p. 61.

Brazil.—The Government-controlled Cruzeiro do Sul Airline, with the assistance of Aero Service Corp., will make extensive airborne magnetic and radioactivity surveys of Brazilian territory.[8]

Several uranium occurrences were discovered in the State of Minas Gerais. The Companhia Morro Velho mined uranium ore at a site near its famous Morro Velho gold mine. A deposit of uranium, thorium, and columbium at Araxa appeared significant, and an occurrence containing 2 to 10 percent uranium at São João del Rei was being studied.[9]

The chairman of the Brazilian National Research Council, Admiral Alvaro Alberto, disclosed that Brazil's first uranium-processing plant may be operating by January 1955. The construction in the next 2 or 3 years of several small experimental reactors was also planned.[10]

Chile.—The Chilean Government was planning a comprehensive search for radioactive materials to be conducted by the mining department of the Corporacion de Fomento de la Produccion with the assistance of the Caja de Credito Minero. The Codigo Minero (mining laws) may be amended by the Chilean Congress to reserve radioactive minerals produced by private industry for the use of the Government. A draft of such a bill was prepared by two congressional committees.[11]

Peru.—Geologists of the United States Atomic Energy Commission surveyed prospective uranium deposits in Peru for 3 months in 1953. High-grade radioactive material was discovered in diverse sections of the country.

Private industry and capital will develop the uranium deposits, and the Peruvian Government will be the only purchaser of the ores produced. A guaranteed scale of prices for the purchase of radioactive ores will be established, and marketing of radioactive products will be the responsibility of the Government.[12]

EUROPE

Representatives of the 10 member countries of the European Council for Nuclear Research (see Uranium, Radium and Thorium chapter, Minerals Yearbook, 1952) and representatives of Greece and the United Kingdom assembled in Paris in July 1953 to consider signing a convention for establishing a European Organization for Nuclear Research, which would succeed the Council (Conseil Européen pour la Recherche Nucléaire, or CERN) when 7 nations, including Switzerland, have ratified the signatures of their respective representatives to the convention. By the close of the year representatives of 10 countries—Belgium, France, West Germany, Greece, Italy, the Netherlands, Sweden, Switzerland, the United Kingdom, and Yugoslavia—had signed the convention, and 2 countries—Switzerland and the United Kingdom—had ratified the signatures of their respective representatives. CERN, a temporary organization, was constituted to plan an international laboratory and organize other forms of cooperation in nuclear research. Construction of the laboratory at

[8] Mining Engineering, vol. 5, No. 2, February 1953, p. 153.
[9] Mining World, vol. 15, No. 9, August 1953, p. 89; vol. 15, No. 10, p. 83.
Canadian Mining Journal, vol. 11, No. 74, November 1953, p. 84.
[10] Atomics and Atomic Technology, vol. 4, No. 12, December 1953, p. 307.
[11] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 3, September 1953, p. 32.
[12] Engineering and Mining Journal, vol. 155 ,No. 1, January 1954, p. 162.

Geneva will be under the direction of the European Organization for Nuclear Research, at an estimated cost of $30,000,000, to be expended over a construction period of 7 years.[13]

Belgium.—The 2,000-kw., nuclear reactor under construction at Moll, in the Campine area of the Province of Antwerp, was nearing completion at the close of 1953.[14]

Early establishment was announced of a research center, either at Moll or at Marche in the Province of Luxembourg, for investigating the application of nuclear energy in the chemical and metal industries.[15]

Bulgaria.—Uranium deposits discovered near Sofia, Bulgaria, were reported under active exploitation in 1953 as a result of pressure exerted by the Soviet Union.[16]

France.—The French Atomic Energy Commission disclosed during the summer of 1953 that a pilot plant to produce 50 to 100 grams of plutonium a day would soon be constructed in the Rhone Valley.[17] Details of the French atomic energy program were published during the year.[18]

Germany, East.—Establishment of an atomic research center at Boehlen, East Germany, to be operated by East Germans with Russian assistance was reported.[19] East Germany would have a share equal to that held by Russia in the reorganized Wismuth Co., according to an announcement attributed to the Prime Minister of East Germany.[20] Control of uranium production in East Germany is held by the Wismuth Co.

Germany, West.—Preparations were said to be under way toward the close of 1953, with Allied permission, to mine uranium ore in West Germany from deposits in the Black Forest and the Fichtel Mountains and to produce uranium at the rate of 9 tons a year.[21]

Netherlands.—The Government of The Netherlands, with participation of Netherlands industry, is attempting to develop a commercial nuclear power reactor. Whether the control of the proposed reactor program will be in public or private hands is unknown.[22]

Norway.—An occurrence of uraniferous graphite was investigated in Glomfjord,[23] and it has been confirmed that uranium is present in granitic deposits at Rendalsvik south of Glomfjord. The economic significance of these deposits has not been announced.[24]

The reactor and nuclear science laboratories of the Joint Establishment for Nuclear Energy Research at Kjeller, Norway, are run jointly by a Norwegian-Netherlands Commission. Radioactive isotopes are produced in the reactor and distributed to qualified European

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[13] Pickavance, T. G., The European Nuclear Physics Laboratory: Atom Sci. Jour., vol. 3 ,No. 2, November 1953, pp. 73–76.
Wentzel, A. L., International Laboratory for Nuclear Research: Bull. Atom Sci., vol. 9, No. 6, July 1953, pp. 223–224.
[14] Chemical and Engineering News, vol. 31, No. 27, July 6, 1953, p. 2745.
Engineering (London), vol. 176, No. 4567, Aug. 7, 1953, p. 179.
[15] Chemical Age (London), vol. 69, No. 1787, Oct. 10, 1953, p. 767.
Atomic Energy Newsletter, vol. 10, No. 10, Dec. 29, 1953, p. 4.
[16] Atomic Energy Newsletter, vol. 10, No. 6, Oct. 20, 1953, p. 4.
[17] Chemical and Engineering News, vol. 31, No. 7, Feb. 16, 1953, p. 687.
[18] Atomic Energy Newsletter, vol. 9, No. 13, July 28, 1953, p. 2; vol. 10, No. 10, Dec. 29, 1953, p. 4.
Bulletin of the Atomic Scientists, vol. 9, No. 9, November 1953, p. 352.
[19] Atomics (London), The French Atomic Energy Project: Vol. 4, No. 8, August 1953, pp. 183–187, 204.
[20] Industrial and Engineering Chemistry, vol. 45, No. 1, January 1953, p. 8–A
[21] Mining Journal (London), vol. 241, No. 6158, Aug. 28, 1953, p. 248.
[22] Chemical Age (London), vol. 69, No. 1794, Nov. 28, 1953, p. 1134.
Bulletin of the Atomic Scientists, vol. 9, No. 10, December 1953, p. 385.
[23] Bulletin of the Atomic Scientists, vol. 9, No. 4, May 1953, p. 145.
[24] Nucleonics, vol. 11, No. 3, March 1953, p. 74.
Atomics and Atomic Engineering, vol. 4, No. 3 March 1953, p. 70.

purchasers. The materials made radioactive included isotopes of cobalt, iodine, sulfur, iridium, and phosphorus.[25] This 300-kw., heavy-water, natural-uranium reactor has been in operation approximately 2 years, and studies were being conducted to determine if heavy-water reactors are technically sound for industrial power purposes.[26]

Spain.—It was reported that geologists, geophysicists, and mining engineers were recruited during the year to develop a uranium deposit underlying the Straits of Gibraltar and outcropping near Algeciras, Spain.[27]

Sweden.—Development of facilities continued for recovering uranium from the oil-shale deposits at Kvarntorp. Operation of the uranium extraction plant near Orebo was begun.[28] The uranium recovered from the kolm-bearing shale is subsequently refined in a special chemical processing plant operated by A. B. Atomenergi, a Government-industry combine.[29]

Construction of an experimental 100-kw. nuclear reactor is expected to be completed early in 1954. The unit will require 3 to 4 tons of uranium and will be moderated with heavy water. It is located underground in Stockholm, and will be operated by A. B. Atomenergi.[30]

The Swedish Government's Atomkommitten, formed in 1945, controls the country's nuclear research program, and it has been estimated that the Government's expenditures on behalf of the program have so far totaled some 42 million kroner, about 8 million dollars in United States currency.[31]

Switzerland.—Geneva will be the site of the European Nuclear Research Center. Construction of the international laboratory will be a 7-year project and at an estimated cost of $30 million. The center is proposed as the headquarters of a 12-European country organization for cooperative nuclear research. (See Europe.)[32]

The Swiss Atomic Energy Commission is planning to build a heavy-water, natural-uranium reactor of 10,000-kw. capacity. The reactor will probably cost about 5 million dollars, funds to be furnished by both the Government and industry.[33]

U. S. S. R.—The Premier of the Russian Government announced on August 8, 1953, that the United States no longer had a monopoly of the hydrogen bomb.[34] In response to requests for comment on the announcement, Lewis L. Strauss, who was appointed Chairman of the United States Atomic Energy Commission July 2, 1953, stated:[35]

> We have never assumed that it was beyond the capability of the Russians to produce such a weapon and that is the reason why, more than 3 years ago, it was decided to press forward with this development for ourselves.

Subsequent statements by the Chairman were to the effect that the Soviet Union had conducted an atomic test on August 12, that the

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[25] Chemical Age (London), vol. 68, No. 1764, May 2, 1953, p. 682.
Atomic Energy Newsletter, vol. 9, No. 7, May 19, 1953, p. 3.
South African Mining and Engineering Journal, vol. 64, No. 3151, part 1, July 4, 1953, p. 755.
[26] Atomic Energy Newsletter, vol. 10, No. 10, Dec. 29, 1953, p. 4.
[27] Mining World, vol. 15, No. 7, June 1953, p. 70.
[28] Nucleonics, vol. 12, No. 1, January 1954, p. 76.
[29] South African Mining and Engineering Journal, vol. 64, No. 3140, part 1, Apr. 18, 1953, p. 219.
[30] Atomic Energy Newsletter, vol. 10, No. 10, Dec. 29, 1953, p. 3.
[31] Work cited in footnote 29.
[32] Work cited in footnote 13.
[33] Atomic Energy Newsletter, vol. 10, No. 10, Dec. 29, 1953, p. 4.
[34] New York Times, vol. 102, No. 34,896, Aug. 9, 1953, Sec. 1, p. 1.
[35] Atomic Energy Commission, Press release: Aug. 8, 1953, 1 p.

test involved both fission and thermonuclear reactions,[36] and that on August 23 a fission explosion took place in Russian territory.[37]

The atomic energy program of the Soviet Union was discussed by a former Chairman of the United States Atomic Energy Commission, in part, as follows:[38]

In any atomic energy program of considerable size, there are four essential ingredients: adequate material resources, including uranium; adequate scientific competence; adequate technological and production capacity; and the determination and ability to unite these three.

* * * the Soviet Union has available to her the uranium ores of the Erzgebirge region of Czechoslovakia and Saxony, one of the world's three historic relatively high-grade sources of this valuable metal, and she is working this region energetically with slave labor. The Erzgebirge region alone could support a sizable atomic energy program. In addition, the geology of the U. S. S. R. is favorable, in a number of areas both east and west of the Urals, to relatively low-grade deposits of uranium ore. Russia should have no more difficulty in working these than we, in the United States, have in working our own relatively low-grade deposits. Taking these two facts together, there is no doubt that the Soviet Union has available sufficient uranium for a large-scale atomic energy program. In addition, in the vast expanses of the Russian Soviet Empire are the fuels, the sources of electric energy, the iron, and the many other natural resources that are essential to a large industrial operation such as an atomic energy program.

Science in Russia today is sponsored and controlled by the government, acting through the Academy of Sciences and the ministries of Higher Education, Health, Agriculture, various industries, and the Armed Services. The Academy is divided into several sections looking after particular fields, such as chemistry, physics, and mathematics. Each section in turn operates a number of institutes. The section on physics and mathematics, for example, has, among others, the Institute of Physical Problems in Moscow, formerly headed by Kapitza, and the Physico-Technical Institute in Leningrad. The institutes work very closely with the universities in the areas where they are located. * * * The total number of people associated with the Academy and its affiliates is probably more than 40,000, including more than 12,000 scientists and technicians. All of this vast scientific machinery can be turned in any direction the government wishes. Much of the work in physics is undoubtedly steered in the direction of atomic energy development * * * The number of higher educational institutions in Russia, most of which nowadays are primarily concerned with producing professional personnel, has increased from about 150 in 1930 to 900 in 1952. During this same period, student enrollments have gone up from about 200,000 to about 1,400,000, including extension-course enrollees, and the annual graduating classes in the Soviet Union now total about 200,000, of which about half are scientific or technical people. This last figure compares with the about 100,000 scientific or technical students who are graduated annually in the United States. About 30,000 engineers were graduated by Russian schools in 1952, and this figure may increase to about 40,000 by 1955. American production of engineers will average about 22,000 annually over the next four years, although the rate is expected to increase substantially thereafter. * * * The quality of professional training in Russia is apparently very good. Admission to Russian institutions of higher learning seems to be largely on the basis of ability, and subsidies by the government make it possible for all individuals of real ability to complete their training.

* * * Russia has the raw materials, including uranium, and the scientific competence necessary to a sturdy atomic energy program. But what of her production and technological capabilities? Is it true, as some GI's returning home from World War II would have us believe, that the average Russian does not even have the mechanical talent to repair a broken jeep? Certainly such an impression prevails widely. And is it true, as some have said, that—while Russia has able scientists and engineers at the top of her industrial structure, and an unlimited supply of labor at the bottom—she is in very short supply of those essential intermediate people, such as skilled craftsmen, shop foremen, and divisional superintendents? There is some truth in this generalization, but it is dangerously misleading. The proof of the pudding, after all, is in the eating,

[36] Atomic Energy Commission, Press release: Aug. 20, 1953, 1 p.
[37] Atomic Energy Commission, Press release: Sept. 1, 1953, 1 p.
[38] Dean, Gordon, Report on the Atom: Alfred A. Knopf, New York, N. Y., 1953, 321 pp.

and Russia during and since World War II has been mass-producing tanks, rockets, artillery, and aircraft of high quality. These are facts, and one hardly needs any more of a current reminder than the behavior of the MIG–15 jet. We have consistently underrated the Russian technological and production achievement, and it is now time we stopped doing it. Her performance during and since World War II is there for us to see, and it is time we started to believe what we see.

The Russian system produces a number of advantages, as well as disadvantages, insofar as the will and ability to accomplish things is concerned. The net result, however, is that there are enough advantages to make it possible for big things to be done in a big way—at a price in human freedom and dignity.

United Kingdom.—Britain's second atomic test series took place on the Woomera rocket range in South Australia during October 1953. What was described as a "utility" bomb, less powerful than that exploded in the Monte Bello Islands on October 3, 1952, was tested on October 15; another explosion was detonated on October 27.[39] Both 1953 explosions were detonated from a steel tower.[40] Woomera rocket range, about 550 miles northwest of Adelaide, was established shortly after the war as a testing ground for new weapons and, reportedly, will eventually cover an immense area extending from Southern Australia to beyond the northwest seaboard, a distance of 1,200 miles on land and a further 1,500 miles out to sea.[41]

Construction of the world's first atomic power station, rated at 50,000 kw., was begun in June 1953 at Calder Hall, Cumberland, England, and scheduled for completion in about 2 years.[42] The reactor is of the thermal type, graphite moderated, and cooled by circulating carbon dioxide under pressure.[43] Selection of a suitable site in Scotland for a second atomic power station was under consideration as the year closed. The large reactor involved would be of the breeder type, also rated at 50,000 kw., and scheduled for completion in about 3 years.[44] The state of atomic energy development in Great Britain and future prospects for atomic power received considerable discussion in 1953.[45]

Shipments of radioisotopes by Britain's Atomic Energy Research Establishment, at Harwell, England, totaled 12,159 in 1953 compared with 9,710 such shipments in 1952.[46] Britain was held to be the world's leading exporter of radioisotopes in 1953.[47]

In November 1953 the British Government announced formation of a new organization, the Atomic Energy Corporation, the function of which would be speedy and economic development of atomic energy for industrial uses in the United Kingdom. Responsibility for atomic

[39] Bulletin of the Atomic Scientists, vol. 9, No. 10, December 1953, p. 385.
Illustrated London News, vol. 224, No. 5989, Jan. 30, 1954, p. 157.
[40] Atomic Energy Newsletter, vol. 10, No. 6, Oct. 20, 1953, p. 4; vol. 10, No. 6, Nov. 3, 1953, p. 1.
[41] Atlantic, Australia: Vol. 192, No. 2, August 1953, p. 16.
[42] Atomic Energy Newsletter, vol. 10, No. 10, Dec. 29, 1953, p. 4.
[43] Hinton, Christopher, Atomic Energy Developments in Great Britain: Bull. Atom. Sci., vol. 9, No. 10, December 1953, pp. 366–368, 390.
[44] Nucleonics, vol. 11, No. 12, December 1953, p. 70.
[45] Goodlet, B. L., The Outlook for Economic Nuclear Power: Atomics (London), vol. 4, No. 12, December 1953, pp. 311–317.
Hacking, John, The Production and Use of Energy in Great Britain: Address before Fifth British Electrical Power Convention, Torquay, England, June 9, 1953; Mining Journal (London), vol. 240, No. 6147, June 12, 1953, p. 694.
Skinner, H. W. B., Atomic Energy in Postwar Britain: Bull. Atom. Sci., vol. 9, No. 5, June 1953, pp. 156–161.
[46] Atomic Energy Newsletter, vol. 11, No. 4, Apr. 6, 1954, p. 3.
Cockcroft. John. Atomic Energy Research at Harwell: Atom. Sci. Jour., vol. 3, No. 4, March 1954, pp. 182–192.
[47] Iron and Coal Trades Review (London), vol. 167, No. 4461, Oct. 9, 1953, p. 857.
Bulletin of the Atomic Scientists, vol. 10, No. 3, March 1954, p. 109.

energy development was to be transferred from the Ministry of Supply to the new corporation as of January 1, 1954.[48]

ASIA

India.—Discovery of uranium in the Damodar Valley was announced in 1953,[49] and drilling operations were reported in progress on uranium deposits found in the State of Bihar.[50] Construction of a uranium-thorium processing plant at Trombay, about 10 miles northwest of Bombay, was begun. The plant will treat uranium-bearing concentrates from Bihar and other parts of India, as well as uranium- and thorium-bearing residual cake from the Alwaye, Travancore-Cochin, monazite processing plant operated by Indian Rare Earths, Ltd. Expectations were that the new Trombay plant would be completed by the close of 1954 and produce about 215 tons of thorium nitrate annually.[51]

A seven-point program pertaining to the development of atomic energy was prepared by the Atomic Energy Commission of India and announced in March 1953 by the Minister for Natural Resources and Scientific Research, according to reports. The program comprised (1) a survey of India for radioactive mineral deposits, particularly uranium deposits; (2) construction of a nuclear reactor; (3) establishment of a medical and health division of the Commission, to protect the health of workers engaged on the atomic energy program; (4) establishment of a biological division, to make fundamental biological investigations utilizing techniques developed in the field of atomic energy; (5) construction of a pilot plant for the extraction of uranium from tailings produced at copper-ore treatment plants and from low-grade uranium ores; (6) construction of a plant for recovering thorium and uranium from residual cake produced at the Alwaye plant in the course of recovering rare earth chlorides and carbonates from monazite; and (7) construction of a plant for the production of uranium of sufficient purity for reactor purposes.[52]

AFRICA

Belgian Congo.—The Shinkolobwe mine of Union Minière du Haut Katanga, in Belgian Congo, continued in 1953 to be a major producer of uranium for the atomic energy program of the United States.[53] In the course of becoming available to the program, the ore mined at Shinkolobwe [54] is placed in steel drums which are loaded on freight cars at Shinkolobwe for transport over a narrow-gage railway to Jadotville, 20 miles east (see fig. 2), and thence northwest about 900 miles to Port Francqui on the Kasai River, where the railway ends. The drums are transferred at Port Francqui to paddlewheel riverboats

[48] Engineering (London), The Atomic Energy Project: Vol. 176, No. 4582, Nov. 20, 1953, p. 657.
Mining Journal (London), Atomic Energy Corporation Formed in U. K.: Vol. 241, No. 6169, Nov. 13, 1953, p. 556.
Economist (London), Franchise for Atomic Energy: Vol. 169, No. 5751, Nov. 14, 1953, pp. 505-508.
[49] Mining Journal (London), vol. 240, No. 6139, Apr. 17, 1953, p. 446.
[50] Atomics and Atomic Engineering, vol. 4, No. 5, May 1953, p. 121.
[51] United States Embassy, New Delhi, India, State Department Dispatch 2199, Apr. 14, 1953, 2 pp.
Industrial and Mining Standard, vol. 108, No. 2743, June 4, 1953, p. 10.
Chemical Age (London), vol. 69, No. 1783, Sept. 12, 1953, p. 536.
[52] South African Mining and Engineering Journal, vol. 64, No. 3140, Part 1, Apr. 18, 1953, p. 243.
[53] Atomic Energy Commission, Fifteenth Semiannual Report: January 1954, p. 5.
[54] Ruch, J. W., Status of Uranium Recovery From Low Grade Sources: Address before Colorado Min. Assoc., Denver, Colo., Jan. 29, 1954.

that follow the Kasai River to its confluence with the Congo River and then proceed down the Congo to Leopoldville, about 500 miles. At Leopoldville the drums are again loaded on freight cars for transport over another narrow-gage railway. This 230-mile rail line traverses some rugged terrain in passing around Stanley Falls in the Congo and winding down through the Crystal Mountains before terminating at the port of Matadi on the Congo, 80 miles from the Atlantic. At Matadi the drums of ore are transferred to ocean freighters which in due course discharge the drums into lighters in the port of New York.[55]

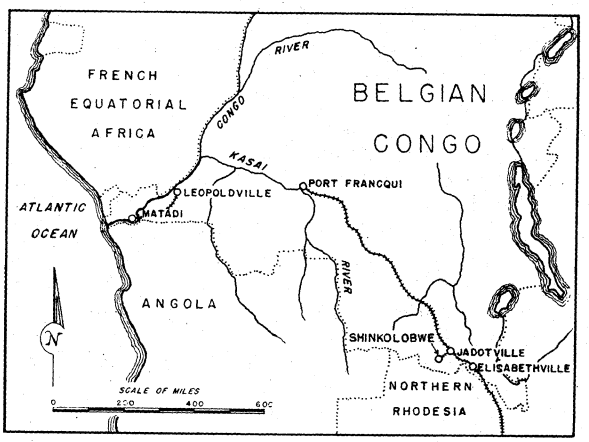

FIGURE 2.—Location of Shinkolobwe mine and ore-transport route to the Atlantic coast.

Details were disclosed in 1953 concerning the initial shipment of Shinkolobwe ore to the United States for atomic energy purposes.[56]

Madagascar.—Processing of uranium ore from the Vinaninkarena mine near Antsirabe, about 100 miles southwest of Tananarive, began in February 1953 at the treatment plant constructed during 1952 at Tananarive, according to reports. Output of the plant is shipped to France.[57]

Mozambique.—A gravity-concentration plant, to treat 100 tons of ore a day, was reported under construction during 1953 at the Mavuzi uranium mines north of Tete. The ore is said to be a disseminated davidite.[58] A pitchblende deposit, apparently the first found in Mozambique, was discovered at the headwaters of the Nhaondoe River, a few miles north of the Zambesi River and at about lat. 15°55′ S. and long. 33°32′ E., according to reports.[59]

Northern Rhodesia.—Pilot-plant investigations were conducted in 1953 at the Nkana copper mine of Rhokana Corp., Ltd., according to reports, with the view of developing a satisfactory flotation process

[55] Deindorfer, Robert, The Forbidden Mines of Katanga: World (magazine), vol. 1, No. 7, February 1954, pp. 17–21.
[56] Gunther, John, Mystery Man of the A-Bomb: Reader's Digest, vol. 63, No. 380, December 1953, pp. 18–20.
[57] Mining World, vol. 15, No. 6, May 1953, p. 75.
[58] Mining World, vol. 15, No. 11, October 1953, p. 85.
[59] Mining World, vol. 15, No. 12, November 1953, p. 77.

for recovering uranium contained in ore from the Mindola section of the mine.[60]

Southern Rhodesia.—Uranium deposits near Beit Bridge and the southern boundary of Southern Rhodesia, which had been tested by the Atomic Energy Division of the British Geological Survey, were acquired in 1953 by Johannesburg mining interests, and erection of a processing plant was anticipated.[61]

Union of South Africa.—Recovery of uranium as a byproduct of the gold-mining industry on the Witwatersrand increased substantially in 1953. Four new uranium-recovery plants, completed respectively by Blyvooruitzicht Gold Mining Co., Ltd.; Daggafontein Mines, Ltd.; Stilfontein Gold Mining Co., Ltd.; and Western Reefs Exploration & Development Co., Ltd., were placed in operation (see fig. 3), making a total of five such plants operative on the Witwatersrand as the year closed [62] [63]—the plant completed by West Rand Consolidated Mines, Ltd., began operations in October 1952 (see Uranium, Radium and Thorium chapter, Minerals Yearbook, 1952).

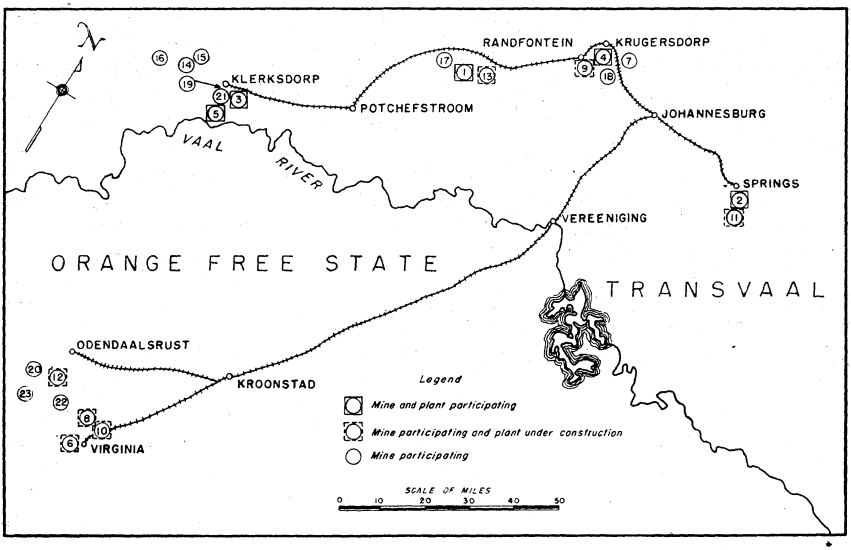

FIGURE 3.—Location of mines and mills participating at the close of 1953 in the South African uranium program.

Companies and the extent of their participation in the uranium-recovery program are shown in figure 3 as follows:

With mines and plants:

1. Blyvooruitzicht Gold Mining Co., Ltd.
2. Daggafontein Mines, Ltd.
3. Stilfontein Gold Mining Co., Ltd.
4. West Rand Consolidated Mines, Ltd.
5. Western Reefs Exploration & Development Co., Ltd.

[60] Engineering and Mining Journal, vol. 155, No. 1, January 1954, p. 154.
[61] Rhodesia and Nyasaland Newsletter, Uranium Mine for S. R. Likely: Government of Rhodesia and Nyasaland, Federal Information Services, Nov. 6, 1953, p. 9.
[62] Work cited in footnote 53, p. 5.
[63] Atomic Energy Commission, Major Activities in the Atomic Energy Programs, January-June 1953.

With mines, but with plants under construction:
6. Harmony Gold Mining Co., Ltd.
7. Luipaardsvlei Estate & Gold Mining Co., Ltd.
8. President Steyn Gold Mining Co., Ltd.
9. Randfontein Estates Gold Mining Co., Ltd.
10. Virginia (O. F. S.) Gold Mining Co., Ltd.
11. Vogelstruisbult Gold Mining Areas, Ltd.
12. Welkom Gold Mining Co., Ltd.
13. West Driefontein Gold Mining Co., Ltd.

With mines:
14. Afrikander Lease, Ltd.
15. Babrosco Mines (Pty.), Ltd.
16. Dominion Reefs (Klerksdorp), Ltd.
17. Doornfontein Gold Mining Co., Ltd.
18. East Champ d'Or Gold Mining Co., Ltd.
19. Ellaton G. M. Co., Ltd.
20. Free State Geduld Mines, Ltd.
21. New Klerksdorp Gold Estates, Ltd.
22. President Brand Gold Mining Co., Ltd.
23. Western Holdings, Ltd.

Eight additional uranium-recovery plants were being constructed at the end of 1953; 4 in the Transvaal by Luipaardsvlei Estate & Gold Mining Co., Ltd.; Randfontein Estates Gold Mining Co., Ltd.; Vogelstruisbult Gold Mining Areas, Ltd.; and West Driefontein Gold Mining Co., Ltd., respectively, and 4 in Orange Free State by Harmony Gold Mining Co., Ltd.; President Steyn Gold Mining Co., Ltd.; Virginia (O. F. S.) Gold Mining Co., Ltd.; and Welkom Gold Mining Co., Ltd., respectively.[64] [65]

A total of 23 gold-mining companies had received authorization to produce uranium by the close of 1953. In addition to the 15 companies holding such authorization at the end of 1952, the following 8 companies were granted similar authorization in 1953: Afrikander Lease, Ltd.; Babrosco Mines (Pty.), Ltd.; Dominion Reefs (Klerksdorp), Ltd.; Doornfontein Gold Mining Co., Ltd.; East Champ d'Or Gold Mining Co., Ltd.; Ellaton G. M. Co., Ltd.; New Klerksdorp Gold Estates, Ltd.; West Driefontein Gold Mining Co. Ltd.[66]

Production of uranium was held to have an important bearing on the future economy of South Africa, inasmuch as it enhanced the value of the ore and would prolong the life of the gold mines both through the greater value and the fact that lower grade ore can be mined.[67] Capital expenditure under the uranium-production program was expected by the Minister of Mines, Union of South Africa, to reach SA£50 million and gross revenue to exceed SA£30 million a year.[68]

The following conclusions were expressed by Davidson relative to the uraninite in the gold ores of the Witwatersrand:[69]

[64] Engineering and Mining Journal, Uranium Soars to Prominence in South Africa's Gold Fields: Vol. 154, No. 5, May 1953, pp. 72–76.
Mining Journal (London), vol. 240, No. 6142, May 8, 1953, pp. 550–551.
Mining Survey (Transvaal Chamber of Mines), Uranium in South Africa: Vol. 4, No. 3, March 1953, 32 pp.
Mining World, vol. 15, No. 7, June 1953, p. 70.
South African Mining and Engineering Journal, vol. 63, No. 3127, Jan. 17, 1953, p. 852.
[65] Engineering and Mining Journal, vol. 154, No. 11, November 1953, p. 174; vol. 155, No. 1, January 1954, p. 154.
[66] Mining World, vol. 15, No. 8, July 1953, pp. 72–73; vol. 15, No. 13, December 1953, p. 73.
South African Mining and Engineering Journal, vol. 64, No. 3141, part I, Apr. 25, 1953, p. 261; vol. 64, No. 3164, part 2, Oct. 3, 1953, p. 151; vol. 64, No. 3181, part 2, Jan. 30, 1954, p. 789.
Work cited in footnote 61.
[67] de Kock, P., The Influence of Our Mineral Resources on the Economic Development of South Africa: South African Min. & Eng. Jour., vol. 64, No. 3160, part II, Sept. 5, 1953, pp. 23–25.
[68] Mining Journal (London), vol. 241, No. 6173, Dec. 11, 1953, p. 687.
[69] Davidson, C. F., The Gold-Uranium Ores of the Witwatersrand: Min. Mag. (London), vol. 88, No. 2, February 1953, pp. 73–85.

In the gold-uranium ores of the Witwatersrand the two pay metals vary sympathetically and are clearly derived from the same mineralization. It is widely held in South Africa that the gold is of syngenetic origin; but since the uranium present (as uraninite) is certainly not of placer deposition this view cannot be maintained. The banket reefs differ from modern auriferous placers in possessing a much higher radioactivity than the latter, due to the ubiquitous presence of uraninite, a mineral which has never been recorded as a detrital constituent of any modern sediment. Conversely the refractory uranium and thorium minerals which account for the radioactivity of placers are absent from the South African ores. The distribution pattern of radioactivity throughout the Witwatersrand Series, as determined by radioactivity logging of boreholes, is wholly dissimilar from that found in normal sediments. Lead isotope studies suggest that the uraninite together with galena (and, by inference, the gold and other sulphides) were introduced into the conglomerates by hydrothermal action about 1,700 million years ago.

OCEANIA

Australia.—Marked progress was achieved in Australia during 1953 toward the establishment of a uranium industry, with indications that in 1954 the Commonwealth would be making a substantial contribution to the world's uranium supplies. Regular production of ore was begun from the uranium-copper deposits at Rum Jungle, Northern Territory, and construction was underway at the close of the year of the necessary plant for commercial-scale exploitation of the titanium-uranium (davidite) deposits at Radium Hill, South Australia.[70] [71]

Exploitation activities in the Rum Jungle field, about 40 miles south of Darwin, were well underway toward the close of 1953, with substantial ore reserves blocked out. Shaft sinking had reached a depth of 490 feet, and a concentration plant under construction was scheduled to begin production in the second half of 1954. Ore was produced during 1953 from an opencut 30 feet deep. About 500 persons were employed in the Rum Jungle operation, which is under the direction of Territory Enterprises Pty., Ltd., a subsidiary of Zinc Corp., Ltd.[72] Geologic investigations held promise that exploration in the Rum Jungle area might uncover ore not indicated by surface radiometric surveys.[73]

Under an agreement executed January 8, 1953, uranium from the Rum Jungle deposits will be sold to the Combined Development Agency, an organization through which the United States and the United Kingdom cooperate in the procurement of uranium. The agreement parallels similar action taken in July 1952 whereby uranium from the Radium Hill deposits would be sold to the CDA (see Uranium, Radium, and Thorium chapter, Minerals Yearbook, 1952.)[74]

Progress achieved in bringing the Radium Hill enterprise to fruition was described, in part, as follows by the Director, Department of Mines, South Australia:[75]

The Radium Hill uranium field is situated 289 miles northeast of Adelaide and 70 miles from Broken Hill. A spur railway line of 11 miles from the main Broken Hill-Port Pirie line will be completed early in October, 1953, thereby providing

[70] Work cited in footnote 57, pp. 5, 6.
Metal Bulletin (London), No. 3785, Apr. 17, 1953, p. 23.
[71] Dickinson, S. B., Uranium and Australia: Address presented July 11, 1953, before the Royal Australian Chemical Institute at Mildura, Victoria, and published in Min. Mag. (London), vol. 89, No. 5, November 1953, pp. 265–272.
[72] Engineering and Mining Journal, vol. 154, No. 12, December 1953, p. 174.
Waylett, W. J., Uranium: Mining World, vol. 16, No. 5, April 1954, p. 47.
[73] Mining Engineering, Rum Jungle: Vol. 5, No. 5, May 1953, pp. 486–487.
[74] Daily Metal Reporter, vol. 53, No. 7, Jan. 10, 1953, p. 1.
Mining World, vol. 15, No. 3, March 1953, p. 59.
[75] Work cited in footnote 71, pp. 268–270.

the field with a direct line of 202 miles with Port Pirie, the site of the chemical extraction plant.

The known uranium deposits comprise a series of lodes adjacent to one another and occupying strong shears in old pre-Cambrian rocks. The lodes are persistent in length and depth, and recent exploration by drilling has revealed promising extensions, especially at the south end of the field. The lodes dip at angles from 30° to 70° and range up to 17 ft. in width; the average width is approximately 4 ft. The deposits are essentially of the vein type and the uranium is present chiefly in an unusual iron-titanium rich mineral which is known as davidite. This mineral also contains a number of other elements—notably, vanadium and rare earths which, together with titanium, may ultimately be recovered as useful byproducts.

The discovery of the occurrence of davidite at Radium Hill actually dates from 1906. It was mistaken for tin ore by the discoverer, Mr. A. J. Smith, a prospector, who sank the first shaft. Its association with a yellow encrustation, a product of weathering, led to its identification by Sir Douglas Mawson as a uranium mineral and eventually as a new uranium mineral to which the name davidite was given after the late Sir Edgeworth David. The original discovery was worked intermittently between 1908 and 1931 for the recovery of radium. It was not until 1947 that the systematic examination of the field was undertaken by the Department of Mines, commencing with geological and geophysical surveys and later with diamond drilling and small exploratory shafts. This testing work revealed a completely new lode system, with the old mine now constituting a very small part of one of the lodes.

The decision to undertake large-scale production was made in March 1952, and at the present time approximately half the approved capital works program has been completed. The establishment, completed for initial production, will cost approximately A£5,000,000 with an annual operating budget of A£2,000,000. The main service shaft has reached a depth of 400 ft. Development work on two levels is well advanced and a third level will be completed before the production date.

For some considerable time the ore from development openings has been treated on the field in a pilot concentrating plant. This plant has provided the basic data for the design of the large-scale concentrator now under construction and has yielded products for chemical extraction studies in Adelaide. The experience and knowledge gained from the operation of this plant will also be most useful in the running in of the new large-scale plant which will treat the full output of the mine. The treatment process combines heavy-medium separation with flotation. The product, a concentrate rich in uranium, will be loaded directly into railway trucks for transport to Port Pirie.

The supply of power to the field by means of a high-voltage transmission line from Morgan on the River Murray, 138 miles distant, is almost complete. It has been constructed by the Electricity Trust of South Australia in a very short time. In October the first power from the Electricity Trust network will be supplied and it will supersede the power from the temporary diesel station now in use.

Probably the most important service to the field is the water-supply pipeline from the Umberumberka Reservoir, 55 miles distant. By arrangement with the New South Wales Government and the Broken Hill Water Board water for the field will come from the Broken Hill water-supply system. A section of the pipeline linking the field with railway dams at Mingary will shortly be completed and by March, 1954, the whole scheme is scheduled for completion.

The uranium extraction plant now being erected at Port Pirie is designed to produce a high-grade uranium salt from the product of the Radium Hill mine—a flotation concentrate containing uranium in association with other minerals—notably titanium, iron, rare earths, vanadium, and numerous minor impurities. The process consists in the main of a leaching circuit with sulfuric acid as the leaching agent. The sulfuric acid dissolves uranium, together with certain other constituents of the concentrates, when heated for a prolonged period at boiling point. After separation from the undissolved material the liquor is subsequently treated for the final extraction of uranium black oxide. The plant is essentially an extension of the concentrating process at the mine. Instead of taking large quantities of chemical reagents required for the final concentration and establishing the plant, together with additional services and highly skilled personnel at the Radium Hill mine, it is more economical to bring the rough concentrates to Port Pirie. Production from the plant is expected in May, 1954. The capital

cost is estimated at A£1,500,000 and when in production the average employment will be approximately 200. Its annual operating budget is estimated at approximately A£1,000,000.

The Port Pirie site has many advantages, both economic and strategic. Its establishment will bring another industry of considerable importance to this northern town, already well known and world famous for its lead smelting and refining operations.

Research and development work connected with Radium Hill has been concerned chiefly with the investigation of methods of extraction of uranium. By March 1952 the ore-dressing process had already reached the pilot-plant stage with very satisfactory results. Although utilizing known ore-dressing methods its success largely depends on a number of unique features evolved after much painstaking and systematic work. On the other hand, at that time, the choice of the chemical treatment process remained undecided. A number of lines of inquiry had been followed, but the most promising required chemical reagents not readily available in Australia. After reviewing the results of the research pro-

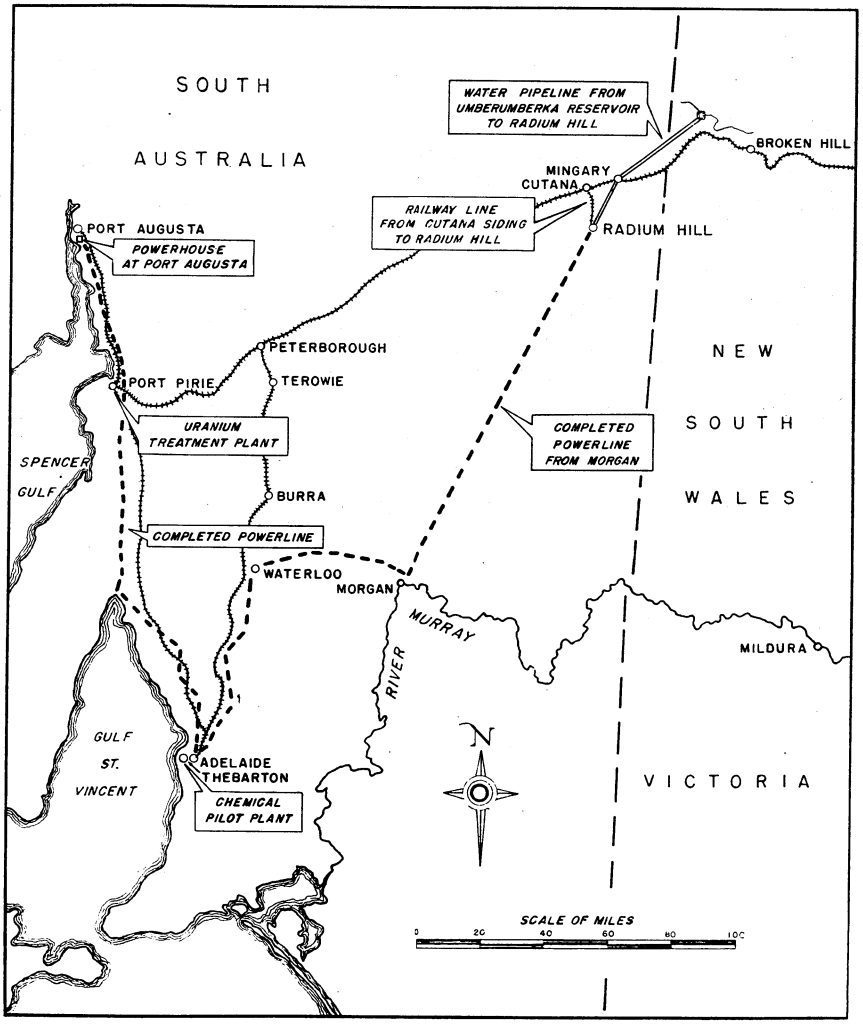

FIGURE 4.—Location of component facilities of the Radium Hill enterprise.

grams, including information made available for the first time from the United Kingdom Ministry of Supply and the United States Atomic Energy Commission, it was decided to use the sulfuric acid leaching technique. While the chemistry of this process was proved, little was known regarding its application in a large-

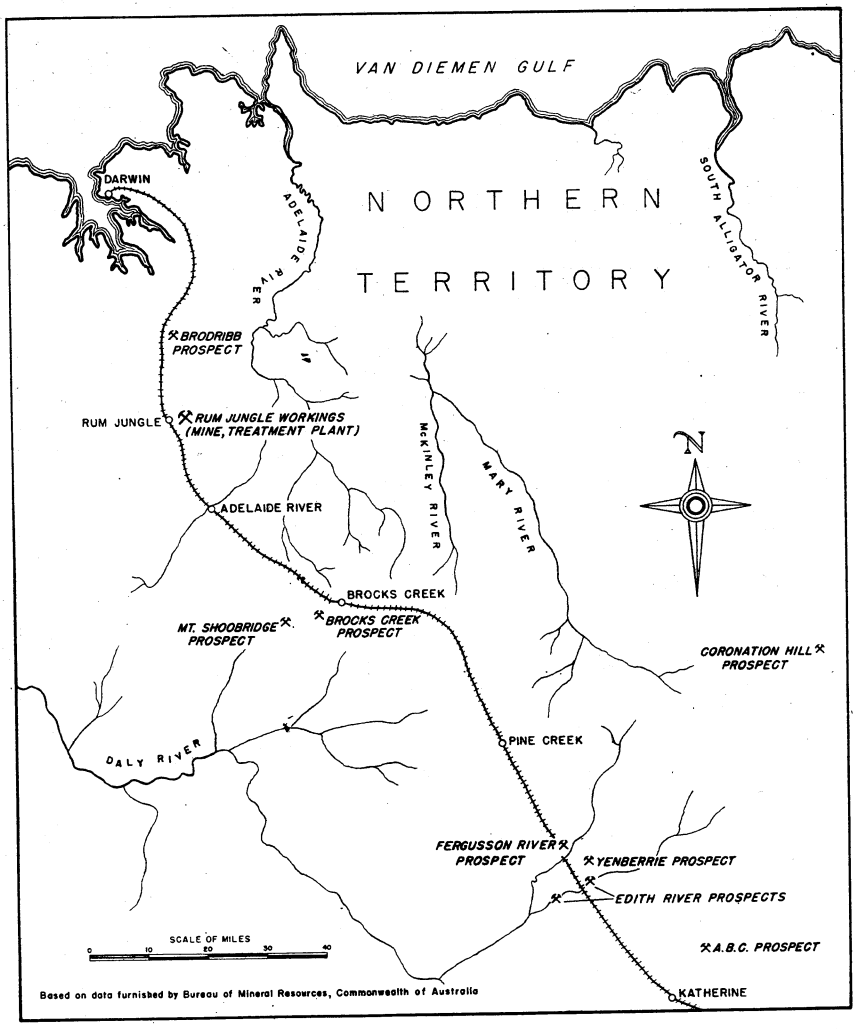

FIGURE 5.—Location of the Rum Jungle area and of nearby uranium discoveries in Northern Territory, Australia.

scale production plant. It was therefore decided to undertake pilot-plant operations with the minimum of delay. In October 1952 the chemical pilot plant at Thebarton commenced operation and has since been running continuously. Several modifications have been found necessary to the original process, but during the early part of 1953 the results have been sufficiently encouraging and adequate to commence the design and construction of the Port Pirie plant.

Two promising uranium discoveries were made in Northern Territory during 1953 according to reports. One, known as the Coronation Hill deposit because it was found on Coronation Day, is situated about 140 miles southeast of Darwin and 55 miles east of Pine Creek; the discovery resulted from an airborne radiometric survey. The other, named the ABC field after A. B. Clarke—a geologist who made the discovery while mapping the area—is situated about 11 miles northeast of Katherine. Drilling was in progress on the Coronation Hill deposit as the year closed.[76]

Other uranium discoveries reported to have been made in Australia during 1953 included three additional deposits in the Crocker's Well area, 40 miles northwest of Radium Hill in South Australia;[77] a discovery of high-grade uraninite ore in biotite schists at Myponga, about 32 miles south of Adelaide;[78] another occurrence along the Edith River in Northern Territory, about 4 miles from the deposit found in 1952;[79] an occurrence discovered along the shore of Lake Dundas in Western Australia, about 350 miles east of Perth and 15 miles south of the town of Norseman, where drilling operations were begun as the year closed;[80] and indications of low-grade uranium deposits in the Broken Hill district, New South Wales.[81]

The Australian Atomic Energy Commission announced a new schedule of prices, effective July 1, 1953, and guaranteed for 5 years, for uranium-bearing ores and concentrates. Designed primarily to encourage the prospecting for and development of uranium deposits, the schedule was applicable up to a limit of 20,000 tons of ore purchased from any 1 producer in any one year. In instances where uranium deposits appeared likely to yield larger tonnages of ore, purchase terms would be subject to negotiation between the producer and the Commission. Purchase points were announced to be Rum Jungle and any other points specified from time to time. Details of the new schedule follow:[82]

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[76] Engineering and Mining Journal, vol. 154, No. 10, October 1953, p. 196; vol. 154, No. 12, December 1953, p. 174.
Mining World and Engineering Record (London), vol. 155, No. 4312, Nov. 21, 1953, p. 304.
[77] Nucleonics, vol. 11, No. 12, December 1953, p. 72.
[78] Gillingham, T. E., Uranium: Min. Cong. Jour., vol. 40, No. 2, February 1954, p. 118.
United States Consulate, Melbourne, Australia, State Department Dispatch 59, Dec. 30, 1953, 2 pp.
[79] Atomics and Atomic Engineering, vol. 4, No. 4, April 1953, p. 99.
[80] Chemical Age (London), vol. 69, No. 1798, Dec. 26, 1953, p. 1332.
United States Consulate, Perth, Australia, State Department Dispatch 16, Dec. 28, 1953, p. 4.
[81] Mining Journal (London), vol. 240, No. 6148, June 19, 1953, p. 731.
[82] Australian Atomic Energy Commission, Schedule of Prices for Uranium-bearing Ores and Concentrates: Circ. 1, June 30, 1953, 3 pp.
Chemical Engineering and Mining Review (Australia), vol. 45, No. 10, July 10, 1953, p. 398.
Atomic Energy Newsletter, vol. 10, No. 5, Oct. 6, 1953, p. 4.

Minimum prices, guaranteed for 5 years from July 1, 1953.

Grade, percent U_3O_8	Price per pound of U_3O_8 in ore	Minimum price per ton of ore, dry weight, at points specified
	A£ s. d.	A£ s. d.
0.25	— 36 —	10 — —
.3	— 36 —	12 — —
.4	— 36 —	16 — —
.5	— 36 —	20 — —
.6	— 36 —	24 — —
.7	— 36 —	28 — —
.8	— 36 —	32 — —
.9	— 36 —	36 — —
1.0	— 36 —	40 — —
2.0	— 37 —	83 — —
3.0	— 38 —	128 — —
4.0	— 39 —	175 — —
5.0	— 40 —	224 — —
10.0	— 45 —	504 — —

Special arrangements will be considered for the purchase of ore of grades lower than those shown in the above schedule, and the price payable will be subject to adjustment in accordance with circumstances. The following are prices which, depending on location, characteristics, and tonnage offered of ores lower than 0.25 percent in grade, might be the basis of negotiation:

Grade, percent U_3O_8	Price per pound of U_3O_8 in ore	Minimum price per ton of ore, dry weight, at points specified
	A£ s. d.	A£ s. d.
0.10	— 14 —	1 10 —
.11	— 16 —	2 — —
.12	— 18 —	2 10 —
.13	— 20 —	3 — —
.14	— 22 —	3 10 —
.15	— 24 —	4 — —
.16	— 25 —	4 10 —
.17	— 27 —	5 — —
.18	— 29 —	6 — —
.19	— 31 —	6 10 —
.20	— 33 —	7 10 —